WATER WORKS & SEWERAGE

L. H. ENSLOW, Editor

THIS MONTH »»

A comprehensive review of the developments during the past year in water supply and purification is given in this issue by Norman J. Howard, Director of Water Purification of Toronto, Ont. A Review of the Progress in Sewage Practice as shown in Current Literature also appears. A new section devoted to Industrial Water Supply and the treatment of Trade Wastes begins with this issue.

AND NEXT »»

The principal articles scheduled for the February issue include the following: Review of Progress in the Sewerage and Sewage Treatment Field, by F. W. Mohlman, Chief Chemist, Sanitary District of Chicago; Filter Sands, by John R. Baylis, Physical Chemist, Bureau of Engineering, Chicago, Ill.; and the Theory and Practice of Aeration in Water Purification and Sewage Treatment, by W. F. Langelier, Professor of Sanitary Engineering, University of California.

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Published monthly by the GILLETTE PUBLISHING CO., Daily News Building, Chicago, Ill.

Entered as Second Class Matter, June 2, 1931, at the Post Office at Chicago, Ill., under the Act of March 3, 1879. Published monthly at 400 W. Madison Street, Chicago, Ill. Per copy 20c. Subscription rates $1.00 per year. Copyright, 1931, by Gillette Publishing Company. Publishers of: Engineering and Contracting, Water Works and Sewerage, Roads and Streets, Tiles and Tile Work, The Art of Mosaics and Terrazzo, Road and Street Catalog and Data Book, Water Works Catalog and Data Book.

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Chicago Office, Daily News Building. Cleveland Office, 952 Leader Bldg. New York Office, 420 Lexington Ave. San Francisco Office, 381 Bush St.

Addresses will be changed as frequently as desired, upon notification: not otherwise. Changes of address should be sent in at least two weeks before the date of the next issue of *Water Works and Sewerage*, in order for them to be effective for that number. Immediate notice should be given of any delay in the receipt of the magazine.

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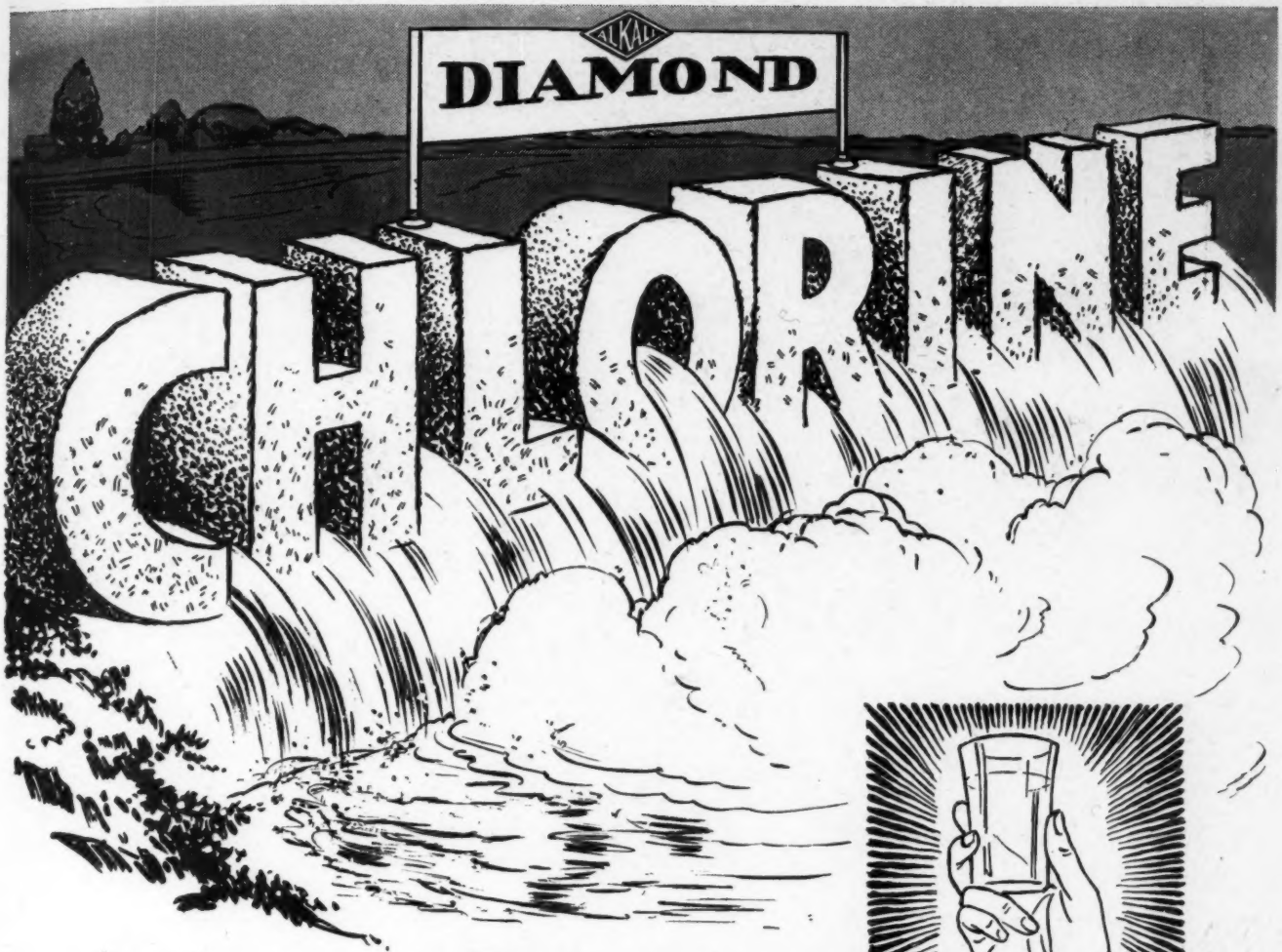

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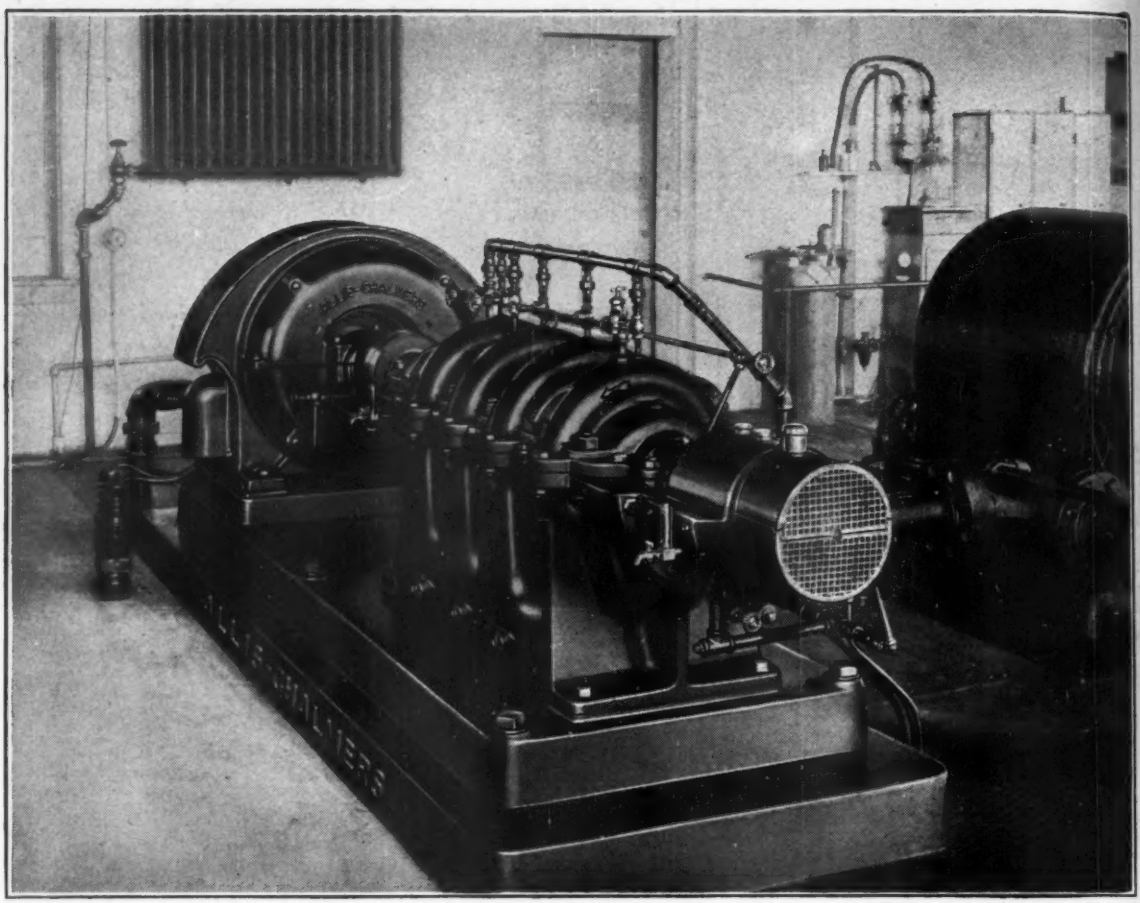


PUMPS worth knowing

5″x4″ Four Stage Type "M" Allis-Chalmers Centrifugal Pump with 200 h.p. Allis-Chalmers 1760 Rev. slip ring motor furnished in 1929 for City of Ironwood, Michigan. Rating 900 g.p.m., 630 ft. head. (Note absence of any vibration—picture taken with unit running.)

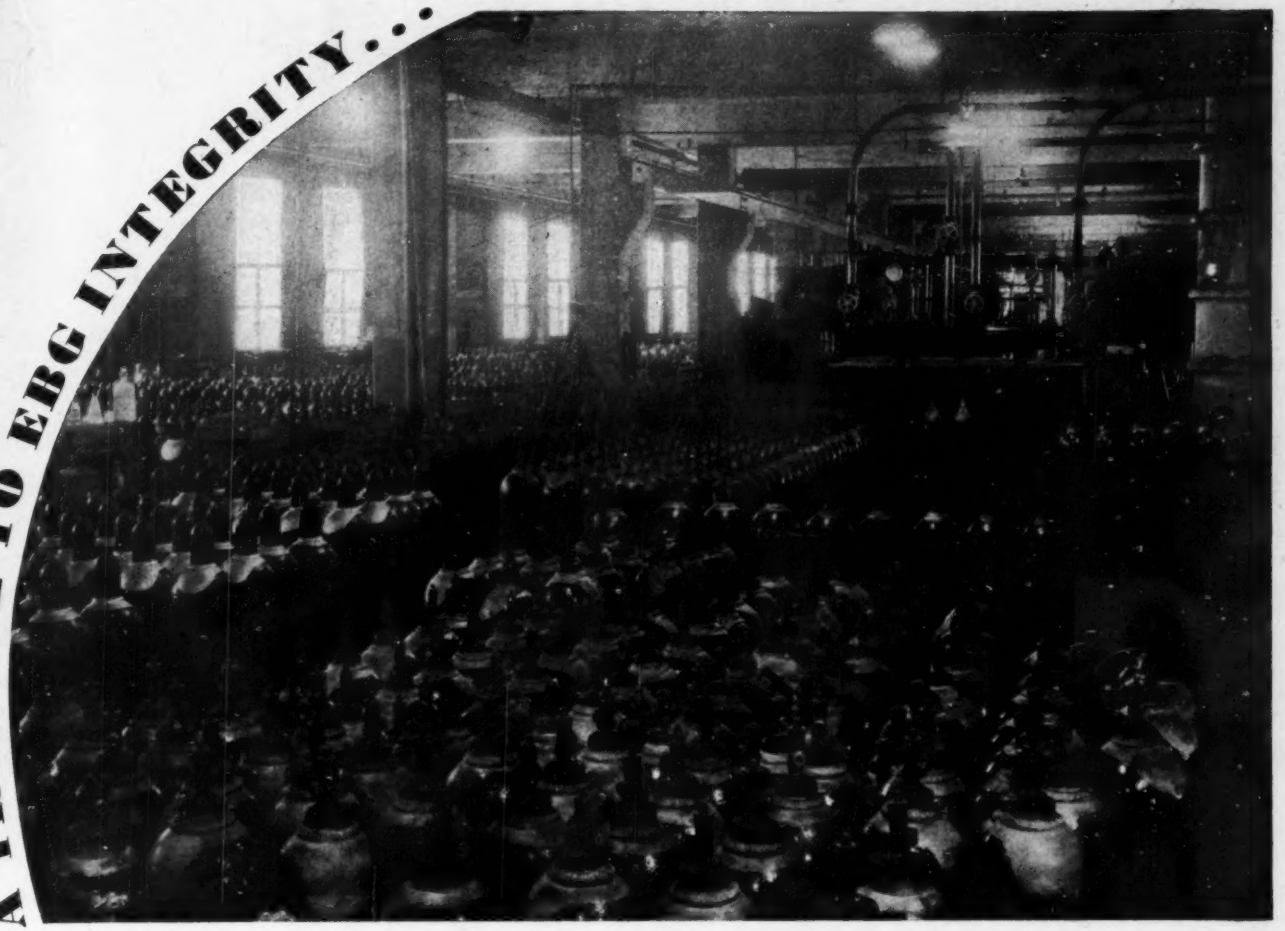
The Allis-Chalmers latest type of multi-stage pumps (Type "M") are proving so remarkably satisfactory and efficient in service that cities can not afford to overlook their advantages even though their first cost may be slightly more than that of other pumps. The unit illustrated has saved the city where it is installed more than twice its original cost in the first year of pumping.

Bulletin 1642 describing the type "M" pump will be sent on request to city officials who wish to investigate the savings possible by installing this improved pump.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee

A TRIBUTE TO EBG INTEGRITY . . .



More than thirty-eight thousand chlorine container units . . . the largest number utilized by any single company in the industry . . . comprise the group at the EBG plant in Niagara Falls. This vastness is, in itself, a tribute to EBG integrity, an indication of the confidence placed in this organization's manufacturing and servicing methods. The list of those who specify EBG Liquid Chlorine is a long one.

The photograph shows a few of the thousands of Red EBG Liquid Chlorine cylinders.

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Pioneer Manufacturers of Liquid Chlorine
Main Office: 9 E. 41st St., New York, N. Y. Plant: Niagara Falls, N. Y.

Look for the RED Cylinder

EBG

Liquid Chlorine

Yes—we would like you to mention WATER WORKS AND SEWERAGE.

WHY SUCH WATER?
To the Editor of The Journal:
Surely, even in politics, there can be no justification for compelling us to drink and cook our food in, and wash our skins with the evil smelling water that runs through our municipal water pipes. We pay for honest water. Why should Creek sewage be wished on us?
The stuff is villainous. It spoils our tea and coffee. It makes spinach impossible. You can't eradicate the taste with anything less than cabbage and corned beef, and that gets monotonous. It is a monstrous mess.
Furthermore, despite denial from official sources, there is something in this so-called water that is not friendly to the human skin. Call it algae or use any other name, or leave it nameless, it is there. I know. I had it or them all up and down my arms. It was a fright. I tried everything from high-power beauty creams to radiator alcohol. Finally I beat the racket with an old-fashioned mustard plaster mixture—three parts of flour to one of dry mustard. This did the trick. Cooked off the algae and left a fair bit of my skin intact. But now—the awful spectre haunts me—What suppose it appears inside? What then? Intern[illegible] mustard plasters
[illegible] feasible.
bathed our tom cat in it recently. He'll never be the same again.
By Drill wells or dig 'em. Raid the filtration plant. Fill up Water Department. If our present Water Department can't handle the situation, let's get one that can. There is good water to be had. Let's have it.
In the meantime, for our lovely city's sake, let's try to keep the matter secret—if we can. A [illegible] man told me the other day that pigs to drink. My civic pride outraged, I told him that it was. But I exaggerated. No self-respecting pig would touch it.
Something ought to be done.
—Sad-Eyed Taxpayer.

POOR TOM!

"He'll never be the same again!"

THE letter at the left appeared recently in a metropolitan newspaper. Read it . . . and you'll echo the writer's final plea "Something ought to be done" about it.

Why hadn't something *been* done before conditions reached the stage pictured by "Sad-eyed Taxpayer"? There can be only one reason . . . *expense!*

Apparently the only way out was through new filtration methods . . . expensive changes in filter plant design . . . or chemical treatments that would require special and costly apparatus.

Actually the remedy is not costly at all

Conditions at least as bad as these have been *easily* corrected without any change in filter plant design, by the use of NUCHAR.

NUCHAR *Powdered* Activated Carbon is fed into the raw water, the water applied to the filters or in the coagulation basin. An ordinary dry feed machine will do the job. The dosage varies of course, with individual conditions.

In an Atlantic seaboard city NUCHAR was successfully used on water taken from the lower levels of the reservoir . . . water practically devoid of dissolved oxygen and having a very disagreeable taste and odor. The amount employed was 5 lbs. per hour, calculated 1/10 of a grain per gallon. After nine hours of NUCHAR treatment the effluent was practically tasteless and odorless.

For full information about this Atlantic seaboard city case and others equally interesting drop a line to the Industrial Chemical Sales Company, Inc., 230 Park Avenue, New York.

WATER WORKS AND SEWERAGE

JAN. 1932

VOL. 79 No. 1

A GILLETTE PUBLICATION

WATER SUPPLY AND PURIFICATION DURING 1931—A REVIEW

By NORMAN J. HOWARD

Director Water Purification, Toronto, Ont.

N. J. Howard
Director Water Purification, Toronto, Ont.

FORCED economies in public expenditures during the past year, necessitated by the world wide depression, did not appear to seriously affect progress in the provision and treatment of public water supplies. Relief work was actually responsible for some increases in waterworks improvements. No radical changes in design were reported, and as in previous years, more progress was made in purification than other phases of water supply and distribution. The increasing demand for safe, physically attractive and palatable water were the reasons for this. The architectural features modern structures, including water towers, were given increased attention. Several beautiful structures were erected in America and Europe during the past year, and doubtless in the future most of the old fashioned ugly standpipes will be modernized. Increasing attention was directed to the advisability of securing initially purer sources of supply, rather than depend upon artificially purified water, often treated at excessive cost. Among other questions considered were improved methods of mechanical agitation, water softening processes, the prevention of corrosion, the limitation of incrustations in water mains, the causes of water main bursts and the elimination of taste and odors. Greater progress was made in this last named subject during 1931 than in any other single year for a considerable time past. During 1929 and 1930, treatment by the ammonia-chlorine process was the feature, but during the past year the application of activated carbon was the chief topic reported upon, and regardless of the great strides made by the use of this substance, it can be safely assumed that its possibilities in the future are unlimited.

New Works and Extensions

In the United States, many large projects and filtration plants were inaugurated or completed during the year. The completion of the Wanaque Reservoir supply for the North Jersey Water District was among the largest supplies of the year. The new reservoir holds 27 billion gallons and depends principally upon storage for purification. To prevent corrosion, lime is added, the pH being kept at approximately 8.0, while copper sulphate is added for the prevention of algal growths in the reservoir. If necessary the water can be aerated, and chlorine is applied through automatic machines. The first stage of the new supply for Albany was completed at a cost of 9 million dollars. This included the abandonment of the Hudson River source in favor of a supply from the Hannacrois-Basil Creek Dam situated 20 miles from Albany. The new supply will be filtered through a rapid-sand plant and will furnish an initial amount of 30 million gallons daily. Considerable progress was reported on the 20-mile tunnel being constructed for the city of New York between Yonkers and Brooklyn at a cost of 45 million dollars. The Cobble Mountain project including both water supply and hydro-electric power, was practically completed at a

cost of 6 million dollars. Completion of the dam on Trinity River near Bridgeport, Texas, for part of Fort Worth's new system was also reported. The dam is 1780 ft. long and 115 ft. high, controlling a storage reservoir having a capacity of 870,000 acre-ft.

The largest undertaking of the year was the starting of work on the Colorado River Aqueduct involving construction of the Hoover Dam. This dam will create a storage space of 30,500,000 acre-ft. at an initial cost of $48,890,909, and will regulate the flow of the Colorado River affording protection against floods. The work will necessitate the construction of a large hydro-electric power plant at the dam site. Work on the Hoover Dam, which is expected to take six years to complete, will bring one stage nearer the supplying of water to the Metropolitan Water District of Southern California and supply an estimated population in excess of 1,600,000.

The new filtration plant at Detroit which will be the largest in the world is rapidly approaching completion at an estimated cost of $9,400,000. Standard rapid sand filters to the number of 68 having a sand area of 1.70 acres will operate at a peak rate of 280 million gallons daily. The water will receive 15 to 25 minutes' agitation after the addition of alum, and will be retained 2 to 3 hours in the sedimentation basins before passing on to the filters. Provision is made for the high velocity back-wash during seasonal variation in temperature.

Extensions at Erie, Pa., were completed at a cost of one and a half million dollars, the new filtration plant having a capacity of 16 million gallons daily. The low service pumps are operated by remote control. One of the features at Erie is the installation of false bottoms in the filters to insure equal distribution of wash water; in addition, copper screens were placed in each filter between the sand and gravel. High velocity back wash having a maximum vertical rise of 36 in. per minute will be employed.

Many new installations of considerable size were reported in Canada. The new Toronto water works and distribution system, estimated to cost 14½ million dollars, has been largely completed, although the filtration plant will not be started until the spring of 1932. The 55 million gallon reservoir is finished and the 9-mile tunnel across the city is being gunited. The cost of these two parts of the work was estimated at approximately 5 million dollars. Great progress was made in the intake tunnel under Lake Ontario, which is expected to be finished this year. The Calgary, Alta., plant and dam are rapidly approaching completion at a cost of $3,770,000. The dam will impound 3,600,000,000 gal. and will supply water to a modern filtration plant estimated to ultimately supply 200,000 consumers. At Winnipeg a new 50 million gallon service reservoir was completed. Four new filtration plants were completed and placed in commission: The plant at Niagara Falls having a capacity of 10 millions; E. B. Eddy plant at Hull, Que., capacity 7 million; Brantford, Ont., capacity 6 million, and the plant at Belleville, Ont., capacity 4 millions. Among other features at these plants are spiral mixing compartments at Niagara Falls, automatic pH chemical feed control at Hull, and Diesel engines as standby units at Brantford. Extensive additions were made to the plant at St. Thomas, Ont., where the spiral mixing system has done remarkable work in aiding coagulation. Large filtration plants were built at Ottawa and Hamilton, Ont., each having a capacity of 30 million gallons. The Ottawa plant costing in excess of one million dollars will be placed in commission early in 1932, while the Hamilton plant is expected to be finished late next fall. Provision is made for ammonia-chlorine sterilization treatment at Hamilton and also for softening which may be utilized at a later date.

In England, a large pressure-filter system was placed in commission at Halifax. This plant consists of 84 units of the Paterson type, has a capacity of 12 million imperial gallons, and includes automatic proportioning control of lime and alum. Mechanical agitators are provided and each filter has a clarity indicator for testing the physical quality of the effluent. In Germany, considerable activity has centered round activated-carbon filters for taste prevention. The new supply for Hamilton, Bermuda, was finished, the water being obtained from an artificial infiltration basin constructed several miles from the city. Completion of a complete water system for Athens, Greece, was reported during the year, the new supply replacing the old one formerly obtained through the Hadrian Aqueduct which dates back to A. D. 117 but was not completed until the 16th century. The Athens system includes a large storage reservoir controlled by a dam. The water flows from the dam through a 20-mile acqueduct to a modern rapid sand filtration plant, designed and constructed by American engineers.

Dam Failures and Engineering Supervision

The failure of water works structures in all parts of the world has occasioned considerable interest. In England, an act was passed during the year which caused a deal of comment among consulting engineers. The act was called "The Safety of Reservoirs Act" and under its provisions a body of engineers designed as a "panel," was appointed to design, supervise, construct and inspect all reservoirs of large capacity. The panel was appointed by The British Ministry of Health and The Institute of Civil Engineers, and only members of the panel are allowed to undertake the work as outlined in the act. Following the collapse of the St. Francis Dam and the LaFayette Dam slip, a committee of experts was appointed in California to investigate the existing structures. A report has been prepared which reveals the necessity for increased care in dam location and construction. Experiences of expert engineers throughout the world indicates the importance of state and federal supervision over the erection of large structures.

Coagulation, Filter Sand and Filter Washing

In the design and operation of rapid sand filters, there is still disagreement as to the value of providing high velocity backwash. Its value has, however, been effectively demonstrated at Cleveland and Detroit, and the new plants equipped accordingly. The question would appear to depend upon the size of sand used and the maximum variation in water temperature. Much work is being done on the effective size of filter sand, and until it is definitely shown that a sand of uniform size can be used for all types of waters, conclusion as to the value of relatively high rates of backwash must remain in abeyance. At the present time there are many effective methods being used for keeping filters in good condition. In a majority of cases the hydraulics involved will not permit high velocity backwash being used. During the year Kansas City carried out considerable experimental work in backwashing filters. It was found that no saving in wash water could be accomplished by reducing the rate of backwash, as the temperature of the water decreased. No improvement was observed in the condition of sand beds when the expansion was increased from 45 to 55 per cent. The work at Kansas City indicated the necessity of a 40 per cent

expansion when the water exceeded 70°F. This kept the sand beds free from mud balls and shrinkage. There is a definite tendency to use a coarser sand, the figures ranging between 0.45 and 0.55 mm. The coarser sand has not been shown to give as high bacterial efficiency as the finer sand, but has been definitely shown to wash more uniformly and cause less filter troubles.

Interesting work was carried out at Cleveland and reported on by W. C. Lawrence. Observations dealing with the necessary retention periods of water in settling basins was found to be directly connected with the density of water. At Cleveland it was found that the greatest density occurred during the first part of April and in the latter part of November. During these periods the water required a settling period of approximately 8 hours. The studies were chiefly made to determinte the bacterial reduction in the coagulated water. At other times of the year the effective retention periods ranged between 2 and 6 hours.

A study was made at Mamaroneck, N. Y., by Alexander Potter and W. I. Klein on the separate use of ferric iron and alum for coagulation. The observations showed a distinct superiority of ferric iron over alum. Temperature was found to have a negative effect when ferric iron was used. For the production of a good floc the pH range was much wider than when alum was used. The color removal control was found to be much simpler, longer filter runs were obtained and filter sand troubles greatly reduced. Other plants have adopted ferric iron coagulation also.

A new chemical feeder was announced by E. W. Bacharach, Kansas City, for accurately feeding any two chemicals simultaneously in different quantities. Another machine was developed by the Omega Company, Kansas, for the application of small amounts of hygroscopic chemicals. The same company have also developed a precision chemical feeder for applying very small quantities of chemicals.

A new device for rapidly detecting changes in turbidity was described by D. D. Gross at Denver, Colo. Turbidity is detected by means of a photo-electric relay system, which consists of a light sensitive device for controlling an electric circuit in response to a substantial increase or decrease in the amount of light falling on it. The new device has been successfully installed at Denver, and is said to be more sensitive than the human eye.

Corrosion Problems Given More Attention

Increasing attention was given to the question of corrosion and considerable progress was made during the year. Several cities are now taking action to prevent corrosion occurring in water mains and household fixtures. In discussing this question, J. R. Baylis, Chicago, gave several reasons why greater progress had not been made. These included (1) lack of agreement until recently as to how corrosion takes place, (2) the theories of corrosion at first confused those attempting to treat water in an effort to prevent corrosion, (3) a few are still hoping that a cheap non-corrosive metal will be found, (4) many still believe that the manufacturer will eventually be able to apply a permanent protective coating, (5) fear of complaints if the water is hardened, (6) indifference to need for preventing corrosion. During the year the American Water Works Association held a symposium on pipe corrosion and corrective methods. This was productive of valuable information and discussion. The subject was summarized by Malcolm Pirnie, who stated that the ultimate and most practical method of dealing with the corrosion problem and red water in outlying districts and distribution systems, may prove to be a combination of three procedures. These included, (1) modification of water treatment by addition of alkalinity to protect the large mains and all others in which rapid and moderate flow may be expected, (2) the use of cement lined pipe in making future extensions and reinforcements of the distribution system, and the use of services of cement or lead lined iron pipes or unlined pipes of copper, lead or brass, (3) modified chlorination to maintain as nearly sterile conditions in the mains as may be practical. The use of ammonia-chlorine treatment offers possibilities in this direction. The use of cement lined pipe greatly increased during the year and several cases were reported in which steel pipe was cement lined and encased before being placed in commission.

The American Railway Engineers Association through their members carried out valuable researches on pitting and corrosion—[A. R. E. A. Bul. No. 333.] The United States Bureau of Standards has been carrying out researches for several years past on the nature and reactions of soils and their relationship to corrosion. A recent publication stated that soils high in soluble salts and consequently low in electrical resistivity, are unusually corrosive to pipe lines. Based upon these studies E. R. Shepard developed a soil meter to record the degree of resistivity measured in ohms-centimeters. The new instrument is expected to be of great practical value in determining the nature of certain soils when large pipe lines are being laid. In England the British Non-Ferrous Metals Research Association has developed a service pipe made of a new ternary-lead alloy. The composition of the piping is 98.25 per cent lead, 1.5 per cent tin and 0.25 per cent cadmium and is said to resist corrosion better than lead. Another paper of interest dealing with pipe tuberculation was presented in England by Arthur Goffey. He found that water treated with sufficient lime to raise the pH up to 8.0-8.3 inhibited the growth of iron bacteria, normally associated with ferruginous incrustations in water mains.*

Increasing Use of Copper and Brass Piping

Due in part to the greatly decreased cost of copper the use of service piping made of this metal greatly increased. The simplicity of installation is doubtless an additional advantage. The action of corrosive waters on copper has been frequently raised, with special reference to the relationship of copper to health. The conclusions of a special committee of the New England Water Works Association appointed to report on this subject follows: (1) The copper content of domestic drinking water after passing through copper or brass pipe or tubing, even if a slight amount of copper is taken in solution, is not harmful to health. It may indeed be beneficial. (2) All water supplies intended for domestic use after passing through a proper installation of copper or brass pipe or tubing will contain but a small percentage of the permissible copper content, if any at all. (3) The permissible copper content of domestic water based on a consumption of 1 gal. of water per day should apparently not be greater than 20 p.p.m. (4) It is unlikely that health will be injured by copper because, where the copper content is about 5 p.p.m. the taste of the water will generally be so disagreeable that it will be virtually impossible to

**Editor's Note:* Independent studies in the laboratories of the U. S. Cast Iron Pipe Co. in America revealed similar findings. It was shown that to a large extent tuberculation of iron may be caused by living organisms.

drink. No anxiety need be felt about a proper installation of copper or brass pipe or tubing, because it has been shown that acid water having a pH value of about 6.5 the copper content is generally only about 0.5 p.p.m., even after standing in the pipe lines for appreciable length of time. (6) The treatment of reservoirs with copper sulphate to rid them of undesirable growths has no injurious effect on health.

Pipe Failure Investigation

In England several serious breaks in water mains resulted in the appointment of an investigational committee by the London Metropolitan Water Board. They found the chief causes of breaks to be (1) Excessive vibration due to traffic when the mains were too near the surface. (2) Direct blow transmitted through the walls of a pit or solid concrete placed immediately over a main. (3) Subsidence of ground owing to deep foundations for adjoining buildings or by pumping operations for the reduction of the level of sub-soil water. (4) Excessive depth of cover over an unprotected main and faulty casting of pipes, e. g., cold strut, cooling, stress, sponginess, unequal thickness of metal, etc. A new paint was announced in England for painting pipes and metal surfaces. It consists of an aluminum paint with a bituminous base.

Water Softening

The question of water softening was frequently emphasized during the year and still remains one of the most important features of treatment. The stumbling block in a majority of cases is the treatment cost, which is admittedly high. It is unfortunately difficult to convince the average consumer of the many advantages and economies which result from a softened water. Recently L. R. Howson, Chicago, stated that soap savings alone would generally amount to three times the expense incurred for water softening. At Columbus, O., C. P. Hoover reported that the average amount of water softened during 1930 was 32.4 million gallons daily, at an average cost for chemicals of $12.91 per million gallons. The hardness was reduced from 268 to 85 parts per million. A comparison of natural zeolite water softening against synthetic zeolite made from silicate of soda and alum was made by D. E. Davis during the year. Both of the zeolites were found to be of equal value in softening. The observations extending over 30 months showed that the average salt requirement had been 0.378 lb. per 1,000 grains of total hardness removed. Each cubic foot of zeolite removed 3,600 grains of hardness at a cost of $11.61 per million gallons. Reduction of 200 parts to 60 parts of hardness involved an additional per capita cost to the consumer of $2.25 annually with a net saving in soap of $10 annually. Churchill Hungerford drew attention to the many advantages greensand zeolite had over other methods of water softening, including durability, their almost instantaneous regeneration and economy of salt and applicability to open tank construction.

Chlorination

The use of chlorine during varying phases of water purification was again extensively reported upon. Some ten years ago, pre-chlorination was revived in America and in the intervening years its use has extended in all directions.

Pre-chlorination treatment for algae control was reported at Los Angeles and Pulaski, Va. At the former city 0.5 parts of chlorine was effective in destroying growths of protococcus without causing taste, while at Pulaski, F. J. Sette found that continuous chlorination of water in the impounding reservoirs will effectively control algae growths. Extensive tests were carried out on a 200,000,000-gal. impounding reservoir. At Brantford, Ont., the alum dosage was successfully reduced from 2 grains to 0.5 grains per gallon by pre-chlorination of the raw water as it entered the coagulating basin. The total cost of chemical was reduced from $4.63 to $1.63 per million gallons of water treated. The ammonia-chlorine combination which followed the pre- and post-treatment of water, made further gains during the year, and is now being used at some places prior to filtration. In the post-treatment which is fairly extensive, there still exists disagreement as to the time period necessary for effective sterilization. With the use of ammonia at some 140 plants in America, this phase should be more generally investigated. Very definite statements based upon close observation, were made at Cleveland, where the time factor was not found to be of importance. On the other hand the extensive work of Gerstein at Chicago, confirmatory work carried out in Toronto and the results of Sir Alexander Houston's researches in England, would seem to leave no doubt as to the importance of prolonged contact if sterilization is to be effected. In dealing with the heavily polluted Mississippi River water at St. Cloud, C. L. Ehrhart found pre-treatment with ammonia-chlorine, to be more effective in reducing the bacterial load than chlorine alone. Septic action was retarded in the coagulating basins and filter runs lengthened. Ehrhart reported that improved coagulation was noticed and that equal color removal could be obtained with the use of less alum. Over all, the treatment was found to be cheaper than when chlorine alone was used. While failures of the ammonia-chlorine treatment in preventing taste largely of phenolic origin have been reported, notably at Bay City, Mich., Rahway, N. J., and Toronto, Ont., the success of the treatment elsewhere has been very favorably commented upon. There are two types of water which do not respond to taste prevention treatment with ammonia-chlorine. These include water having an initial taste before treatment and water heavily polluted with phenols and high in organic matter. So far as the writer knows these factors have been involved in all cases where the treatment has been unsuccessful. The experiences reported by E. C. Goehring at New Brighton, Pa., are of interest. In dealing with a bad water he found ammonia-chlorine treatment completely effective in eliminating earthy, musty and fishy tastes and odors but ineffective in removing chlorophenol tastes and odors. He pointed out, however, that the water *contained taste before treatment.* Goehring is amongst the first to draw attention, based upon actual operation, to the importance of studying the most suitable points of application. He found that when the ammonia was added to the raw water entering the sedimentation basins a loss of from 5 to 25 per cent resulted. After passing through the filters an additional loss of from 40 to 60 per cent. Goehring states that the ammonia should be added before the addition of chlorine and applied where possible to the filtered water entering the clear water well. When applied at this point, the treatment will be found to be considerably cheaper due in part to full use being made of the ammonia. J. E. Lyles reported that the ammonia-chlorine treatment was completely effective in preventing the formation of medicinal tastes and odors at Tampa, Fla. An amount of $2,000 was saved during the year by use of the chloramine treatment. When the ammonia salts were first used in England, ammonium chloride was tried but was later replaced by ammonium sulphate, the substitution

being suggested by Sir Alexander Houston. In America, H. E. Jordan, Indianapolis, inaugurated the first continuous use of the sulphate and reported upon the successful elimination of taste and prevention of bacterial aftergrowths. Sulphate of ammonia is being used also at Detroit, while in Canada its use has been started at Windsor, Ont., and at Galt, Ont. Amongst the outstanding contributions of value published during the year directly dealing with ammonia-chlorine treatment were papers by Linn H. Enslow on ammonia-chlorine reactions, and articles of general interest and value by John C. Baker and F. C. Schmelkes and also by J. F. T. Berliner.

Super and Dechlorination

Super-chlorination of the Glencoe, Ill., supply was successfully applied for taste prevention under the control of F. L. Pflanz. The normal dose of from 1.0 to 1.5 parts per million was raised to 3.0 parts and applied to the water entering the coagulating basin. A total contact period of 6 hours was available, and after passing through the filters, a residual of 0.5 parts was removed by the addition of bisulphite of soda. It was found that each part per million of chlorine required 1.6 parts bisulphite. One of the newly developed Omega rotary dry feeders was used for applying the dechlorinating reagent.

Special mention should be made of an outstanding paper contributed during the year by B. A. Adams, England, dealing with the causes of taste in chlorinated water supplies. Adams reviewed the subject at considerable length and in view of the extensive nature of his researches the paper is of great reference value. In another paper, Adams refers to the ineffectiveness of ordinary methods generally employed for the removal of earthy and musty tastes and odors, and emphasizes the value of activated carbon in removing tastes. Extensive observations made by the author in Toronto and confirmed by J. R. Baylis, Chicago, indicate that excessively polluted water containing phenols can be successfully treated by super-chlorination for prevention of chloro-phenol taste, but that in such waters a musty and earthy taste may remain. Baylis showed that super-chlorination followed by filtration through activated carbon would effectively remove both the chloro-phenol and musty tastes and odors.

Activated Carbon Applications

The application of activated carbon within the next few years, promises to eclipse all other methods at present in use for the physical treatment of water supplies. While its use is not new, the researches of John R. Bayliss in America, of Dr. Beale in England and of Drs. Bailleul, Pick and Sierp in Germany have done much to establish confidence and start experimental work in all parts of the world. The use of activated carbon as a dechlorinating reagent, its phenol adsorptive properties, its utility as a taste remover and its remarkable color removing properties make it an ideal medium for water purification.

Powdered activated carbon promises much in the future due to its simplicity and economic method of application, and the fact that costly equipment and additional filters have been found to be unnecessary. In reviewing all methods at present in use for the prevention of offensive tastes and odors, activated carbon results are the most convincing and reliable.

At Bay City, Mich., L. B. Harrison reported upon the installation of a complete activated carbon filter, the sand having been removed from a rapid sand filter and replaced with a bed of carbon 24 in. thick. The cost of 1,400 cu. ft. of carbon placed in the filter was $5,600. While the filter has not been extensively used its results are said to have been satisfactory. A "Hydro-Darco" carbon adsorber was installed at Dundee, Mich., having a maximum capacity of 10 gal. per square foot per minute. Credit for the introduction of powdered carbon in water treatment is due Geo. R. Spalding of the Hackensack Water Co. A. E. Stearns described the use of activated carbon in powder form at Hamburg, N. Y., for the removal of musty, fishy and medicated tastes which seasonally occurred in the water. No adverse effect was noticed on the filters, the loss of head not being affected. At the 11th annual meeting of the Ohio Conference on Water Purification, numerous papers were presented giving details of activated carbon treatment within the state. The experiences are of great value due to the known conditions which exist in so many of the supplies in this area. At Defiance 0.30 to 0.48 grains per gallon were added to the water prior to its entering the carbonation chambers, at Sandusky approximately 0.1 grains per gallon was applied while the same amount was added at South Pittsburg. The treatment was successful in eliminating various types of taste at all places. Two instances of failure to remove taste were described, the first at Warren where the dose was unsuccessfully increased up to 1.8 grains per gallon and at Topeka where the dose was 0.60 to 0.72 grains per gallon. Early failure was reported at Youngstown when using 0.30 grains but when the dose was raised to 0.90—0.96 grains per gallon, the treatment was successful. Outside of Ohio, numerous other installations were made during the year. At Norfolk and Newport News, following the application of 0.09 grams per gallon of powdered activated carbon, the use of ammonia-chlorine for taste and odor prevention was discontinued. The carbon was not found to penetrate the filter-beds to a greater depth than 10 in. Interesting dosage and cost figures from other places are of interest: Newcastle, Pa., 0.195 grains, $1.35 per M. gal.; Olean, N. Y., 0.045 grains, $0.39 per M. gal.; Washington, Pa., 0.090 grains, $0.78 per M. gal.; Morgantown, W. Va., 0.10 grains, $0.70 per M. gal.; Daytona Beach, $1.40 per M. gal. An excellent paper was recently prepared by F. H. Waring, Columbus, dealing with the application of carbon and costs involved. He stated that reasonable costs of activated carbon treatment for removal of tastes originating from algae, heavily polluted and stagnant waters, is up to $2.10 per million gallons, the carbon dosage varying between 0.06 and 0.6 grains per gallon. According to figures furnished by the industry there are 174 plants in America using carbon in water or sewage treatment.

"Oligo-Dynamic" Sterilization

A paper of considerable interest was presented before the Public Works, Roads and Transport Congress, by Dr. E. V. Suckling, England, on the sterilization of water by Catadyn silver. This has attracted more attention in Europe than in America. The process is sometimes described as the "oligo-dynamic process." The most recent development is the introduction of the metal into water by an electrolytic process which is said to have simplified the application and also reduced costs of treatment. According to Dr. Suckling, Dr. Krause of Munich, has discovered a method of bringing certain metals in contact with water so that active molecular oxygen is accumulated. Metallic salts are formed in minute quantities which dissolve and form positive ions which have been shown to destroy bacterial life.

NATURE'S RAIN-GAGES SHOW WEATHER CYCLES

By HALBERT P. GILLETTE

THE earliest annual rainfall record begins with the year 1689 in Paris. The earliest American record begins in 1738 at Charleston. The earliest Pacific Coast record begins in 1842 at Sitka, Alaska. In California the earliest records begin in 1849 at San Francisco, Sacramento and San Diego.

The high and low water stages of the Nile were recorded for several thousand years, but the early records have been destroyed. The earliest record in existence starts with the year 616 A. D. While there are a number of subsequent breaks in the Nile record, still it forms a very complete picture of rain runoff in northeastern Africa, by years, for more than 1300 years.

If we are to solve the problem of long cycles of precipitation we must use what may be termed Nature's rain-gages. Of these only two kinds are known, namely, annual tree-rings and annual silt laminæ called varves. Douglass has measured the annual rings of the California redwoods, or sequoias, back to the year 1306 B. C., so this gives a natural record incomparably superior to any short man-kept record of relative annual rainfall. While the sequoias do not furnish an accurate annual record of rainfall, they do give a record sufficiently good as a means of determining many rainfall cycles with great accuracy.

The Arizona pines are preferable to the sequoias as rain-gages. Douglass measured living pines back to 1392 A. D., and has carried that record back to 700 A. D. by measuring the rings in house timbers in the ruins of ancient homes of Indians in Arizona and New Mexico. This remarkable achievement suggests that search for buried logs in river beds may result in the discovery of rain-gages of great antiquity. By matching their rings, as Douglass has been able to do, there is likelihood that tree records can be carried back to a much earlier date than 1306 B. C.

The other class of natural rain-gage is the varve. Gerard de Geer, of Sweden, has been the pioneer measurer of annual varves. He has secured a continuous record in Sweden that goes back about 18,000 years, with a small gap of less than 200 years between the youngest varve and the present time. Antevs has measured the varves of the Hudson and Connecticut River valleys and of Canada to the north thereof, and has published three splendid monographs giving his measurements. His varve series goes back as far as that of de Geer in Sweden, but there are several gaps in the Antevs' series. It is highly important that these gaps be closed by further research, for an American rain-gage covering some 18,000 years will serve to determine many long rain cycles.

The writer has used, successfully, varve measurements to check the lengths of many rain cycles previously found by the Stewart cyclogram analysis both in tree-rings and in annual rainfall. Hence there is no question as to whether varves are rainfall gages of sufficient accuracy for the purpose of finding rainfall cycles.

Both de Geer and Antevs regard the variations in varve thickness as being mainly due to variations in temperature which affected the runoff from glaciers, and therefore the rate of silting in glacial lakes. While temperature is a factor in such runoff, the writer's studies indicate that it is of minor consequence as a cause of annual variation in varve thickness

About two years ago Wilmot H. Bradley, of the U. S. Geological Survey, published a remarkable paper on "The Varves and Climate in the Green River Epoch." Bradley has discovered that the oil-shales of Wyoming, Utah, and Colorado are varved like the clay deposited in ancient glacial lakes. He has found evidence of three weather cycles in these varved shales, one apparently the length of the 11.2-year sunspot cycle, one of about 50 years, and one of about 21,600 years. He mentions the fact that David had found a cycle of about 11 years in the glacial varves of Australia, and that Perfiliev had found a similar cycle in the mud varves that have been and are being deposited in Sakski Lake. He also mentions that Kremser found a temperature cycle of about 50 years in Germany, but he fails to mention that Brooks found a 51-year cycle in the glacial clay varves of Argentina. In the fall of 1930 the writer found a cycle of 52.6 years both in the sequoia tree-rings and in the clay varves of Connecticut by using the Stewart cyclogram analysis. This cycle was published in WATER WORKS AND SEWERAGE, February, 1931. The next peak of this rain cycle will be about 1936.

Bradley found 16 cycles of about 21,600 years, some of which seem to overlap. Aside from the importance of finding a weather cycle of such great length, the existence of a natural rain-gage that probably covers more than 200,000 years is of supreme importance. The short chart of varve thicknesses that Bradley has published bears striking resemblance to the clay varve charts of de Geer, Antevs, and Reeds.

In the mud varves formed and still forming in existing lakes, in the clay varves of ancient glacial lakes, and in the oil-shale varves of the Eocene epoch, Nature has provided crude rain-gages by the aid of which man can solve the difficult problem of weather cycles. Since long range weather forecasting depends entirely upon the solution of the cycle problem, it follows that Congress should make liberal appropriations for measurements of the kind that de Geer, Antevs, Reeds, and Bradley have made in the realm of the varves, and that Douglass and Huntington have made in the realm of tree-rings. If the Weather Bureau were given as little as $100,000 a year for this purpose, it is not unlikely that within 10 years Nature's rain-gages could be forced to disclose the important rain cycles with such a certainty that all doubt would vanish.

The writer has devoted the equivalent of four years of continuous effort to find weather cycles and their cause. Tree-ring and varve data have been indispensable in this research; but there is sorely needed more of those data. These natural records should be thoroughly investigated in America, and, indeed, throughout the globe.

Accurate long range weather forecasting is in sight, but a vast deal of work remains to be done, both in the gathering and in the cyclogram analysis of tree-ring and varve data. There is likelihood that fully 100 weather cycles exist. The complexity of the problem resulting from even half that number is dismaying. None the less, if the lengths and peak dates of all the important cycles are determined, we may be sure that it will be possible to calculate their resultant effects, many years in advance, with considerable accuracy.

INDUSTRIAL WATER SUPPLY ·AND TRADE WASTES·

An Announcement

BEGINNING with this issue, WATER WORKS AND SEWERAGE adds a section dealing with *Industrial Water Supply and Trade Waste Treatment.*

A paper in this section by P. W. Frisk, Chief Chemist of the American Enka Corporation discloses a unique method of purification of a water for use in rayon manufacture. It is well known that the manufacture of artificial silks of all kinds, cellophane and high grade pulp (alpha-cellulose) used in the production of these products requires a water of high purity, free of iron, manganese and turbidity and low in hardness and color. Mr. Frisk tells of a problem met at the Enka plant wherein manganese and color removal from the water was essential, but at the same time a finished water approaching neutrality on the (pH) scale was necessary for the production of rayon at that mill.

Manganese in water supply is becoming increasingly recognized to be a problem at high grade pulp and paper mills, artificial silk mills and textile mills. There are other means employed for manganese removal but that devised at Enka, N. C., will serve a useful purpose where relatively high pH values in the finished water which would result from the iron-lime process of coagulation can not be tolerated.

The report covering the Symposium on Industrial Wastes and Stream Pollution which was held at the recent meeting of the American Institute of Chemical Engineers is introductory. Articles dealing with trade wastes and their treatment will appear in subsequent issues.

Contributions in the nature of articles or news items to this new section on *Industrial Water Supply and Trade Waste Treatment* will be particularly welcome.

MANGANESE IN RESERVOIRS AND HOW IT MAY BE ELIMINATED

By PAUL W. FRISK, M. S.

Manager of the Chemical Laboratory, American Enka Corp., Enka, N. C.

WATER for use in chemical industries is of great importance not merely from a sanitary standpoint, but particularly from the standpoint of mineral purity. Those industries which rely upon reservoirs as a source of water supply may be confronted with complex problems of water treatment during the fall and winter seasons and immediately after a sudden decline in temperature if proper precautions are not taken. It has been the problem and experience of the writer to work out a treatment for water which was giving such difficulty.

In the literature that has been reviewed, there appear many other instances where a large amount of manganese and iron has been allowed to accumulate in the bottom stratum of a reservoir, resulting in difficult problems at the water treatment plant when the entire con-

Plant of the American Enka Corp., Near Ashville, N. C. Reservoir Is Shown in Left Background

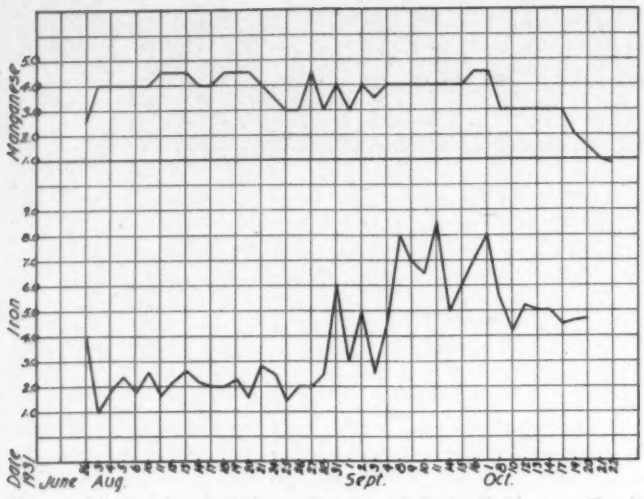

Fig. 1—Manganese and Iron Content of Lake Enka at a Depth of 30-32 Ft.

tent of this concentrated stratum became diffused throughout the reservoir. At the American Enka Corporation, a rayon plant located near Asheville, N. C., we encountered a similar unexpected experience. The corporation had built an artificial lake having a capacity of 300,000,000 gal. This lake was originally intended for a large water reserve, enabling us to safeguard against drought. When we later commenced using water from the lake daily we discovered after some time that there had been a building up of a relatively high concentration of manganese and iron through the decomposition of organic vegetable matter at the bottom of the lake. This condition of which we were unaware at that time, resulted in a water which was rather difficult to treat at the moment and about which more will be said in this paper.

The water supply in the lower Hominy Valley, where our plant is located, comes from the water shed on the lower northern slopes of Mt. Pisgah. This water shed is well protected and covers an area sufficiently large to supply 20,000,000 to 30,000,000 gal. per day. This area is well covered with timber which protects the water shed from erosion and consequently maintains the mineral constituents at a minimum.

The rocks in the soil of the northeastern slopes of Mt. Pisgah are rich in manganese and iron bearing ore. The surface soil contains manganese and iron which is easily dissolved in the water when organic matter is allowed to decay at the bottom of the reservoir.

The reservoir, or artificial lake, which will be discussed in this paper, covers an area of 75 acres, has a length of ¾ mile to 1 mile and a width of 300 to 400 yards at its broadest point. It is 2,098 ft. above sea level and has a drainage area of 5½ square miles, with a total capacity of 300,000,000 gal. It is fed by nine small streams including a spring.

The lake, or reservoir, is situated at a distance of about one mile from the filter plant. Hominy Creek, with a flow of about 20,000,000 gal. per day, passes by the filter plant and water from this creek is pumped to the lake at night. By drawing down during the day and pumping into the lake at night, it is possible to maintain a constant volume of water of uniform quality in the reservoir.

The natural supply of this reservoir is normally sufficient to supply 4,000,000 gal. for factory use plus 500,000 to 750,000 gal. to compensate for surface evaporation per day.

Previous to the experience with which this article deals we had found the water in western North Carolina to be moderately pure and easily treated. It is not highly colored or polluted with domestic or industrial wastes, as is true of our eastern water supplies. The lake was partly filled during the spring and summer of 1929 and by the end of the summer, due to the heavy rains, there was sufficient water in the reservoir to begin drawing it off to the filter plant. At that time and during the subsequent winter of 1929-30, treatment of the water offered no particular difficulties. During the summer of 1930 a comparatively small accumulation of impurities made itself evident and had an ill effect on filtration, resulting in decreasing of the length of filter runs and the efficiency of operation. The turbidity during that summer was very low, requiring a proportional adjustment of chemicals.

During the summer of 1930 the decomposition of vegetable matter at the bottom of the lake, which resulted in solution of manganese and iron, made considerable progress though it was not at its maximum, as

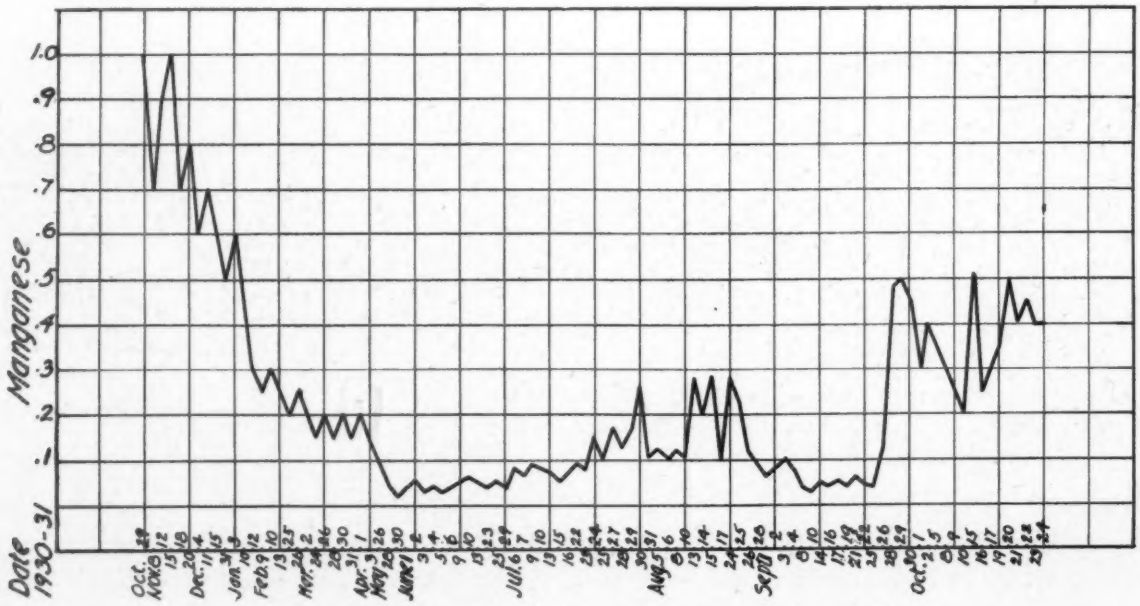

Fig. 2—Manganese Content of Lake Enka at a Depth of 6 Ft.

proven by later observations in 1931. During this same period, numerous micro-organisms appeared. Analyses of the lake water at the surface and at various depths were made to ascertain the chemical and physical composition. These analyses revealed an increase in turbidity, iron, manganese, and carbon dioxide, with a decrease in oxygen proportionate to the increase in depth.

These impurities were found concentrated in the lower strata of the lake, as shown by comparison of Figs. 1 and 2, and contained to prevail until the level of the lake was drawn down, as will be described later. It was apparent that the manganese concentration at the bottom of the lake at the end of the hot season was more than ten times as high as it was at a depth 6 ft. from the surface.

These layers or strata of impurities remained as such until there was a suddent disturbance of equilibrium through change in temperature of the top layers of the lake, due to the cooler fall weather, which resulted in the turn-over of the water in the lake. This happened during the month of October, 1930. At that time we were not quite prepared for this new condition, and, therefore, this occurrence developed into an immediate difficulty at the treatment plant, as the excessive amounts of manganese and iron could not be completely removed by the process in use.

Steps taken to handle the condition were as follows: Since it was not possible to adopt at once an elaborate method of treatment or to apply any of the well recommended and active treatments, and as we were confined to the use of the rather simple treatment and the gravity filtering equipment that was available at that time, the treatment consisted in adding alum and soda and hypochlorite as coagulants for the oxidation of organic matter and iron. On account of the large demand for filtered water at that particular time, our mixing time was only about 15 to 20 minutes, while the sedimentation period was 3 to 3½ hours. This was considered to be a very short time for a contact period, not sufficient for the oxidation of all manganese and iron present, as only a low concentration of hypochlorite was used. The precipitation was slow, and with the addition of organic matter the settling of the floc was greatly retarded.

Our best chance to conquer the situation was to increase the coagulant and to add potassium permanganate in the same tank as the alum, which would result in a more complete oxidation of the manganous salts, precipitating manganic hydrate and manganese dioxide.

The dosage of potassium permanganate used was approximately 1.4 parts per million to every part per million of manganese in the raw water. It was found possible to oxidize the manganese in the water sufficiently to cause precipitation, provided that a pH of 6.8-7.0 was maintained. Only 65 per cent to 75 per cent of the manganic hydrate settled out in the basin and the remainder reached the filters.

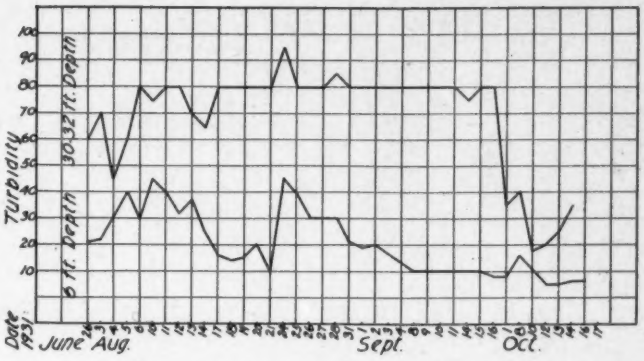

Fig. 3—Turbidity of Lake Enka at a Depth of 30-32 Ft. and at a Depth of 6 Ft.

As the use of potassium permanganate was continued the building up of the Mn_2O_3 and MnO_2 combined with the organic substances on the filters decreased the filter runs to such an extent that it became difficult to continue operation. During this time the hypochlorite was being fed at the rate of approximately 1.0 p.p.m. available chlorine, which gave a final residual chlorine value of 0.4 to 0.5 p.p.m. in the filtered water. It was not possible to add higher concentrations of chlorine, as we had no immediate means by which to dechlorinate. It became a problem to determine how the filter time could be increased by the proper adjustment of the dosage or by substituting another coagulant.

It was considered possible that by substituting sodium aluminate for part of the aluminum sulfate, we could produce a heavier floc, which would in turn carry down more of this suspended manganic hydrate. Experiments with jar tests on a laboratory scale were made to obtain the correct dosage, after which further tests were made to determine the optimum dosage for our particular water.

Table I illustrates what dosage resulted in the best flocculation and settling.

From this table it will be noted that 0.22 grains of commercial liquid sodium aluminate per gallon of raw water gave the most satisfactory results.

During the great number of coagulation and sedimentation tests made, it was observed that it was neces-

TABLE I—JAR TEST; TEST FOR SODIUM ALUMINATE DOSAGE, LAKE WATER, MAR. 4, 1931

No.	$Al_2(SO_4)_3 18aq$ Gr./gal.	Soda Gr./gal.	Aluminate Gr./gal.	$KMnO_4$ Gr./gal.	Cl Gr./gal.	pH *	Floc: Time in Min.	Floc: Character
1	1.84	1.27	0.174	0.015	0.17	6.3	10	Fair
2	1.84	1.27	0.180	0.015	0.17	6.5	10	Very Good
3	1.84	1.20	0.19	0.015	0.17	6.5	10	Fair
4	1.84	1.20	0.20	0.015	0.17	6.4	10	Fair
5	1.84	1.15	0.21	0.015	0.17	6.4	10	Fair
6	1.84	1.15	0.22	0.015	0.17	6.5	10	Excellent
7	1.84	1.15	0.24	0.015	0.17	7.1	10	Good
8	1.84	1.00	0.26	0.015	0.17	7.1	10	Fair
9	1.84	1.00	0.28	0.015	0.17	7.1	10	Fair
10	1.84	1.27	0.16	0.015	0.17	7.1	15	Poor
11	1.84	1.27	0.13	0.015	0.17	7.1	15	Poor
12	1.84	1.27	0.10	0.015	0.17	....	....	Poor
13	1.84	1.30	0.07	0.015	0.17	....	....	Poor

*After floc was formed.
Tests No. 1 and No. 6 showed a distinct difference in quality of settling, although the time was the same. The floc was heavier.
Raw Water:
pH—7.0
Alkalinity HCO_3—12.8
Turbidity—6

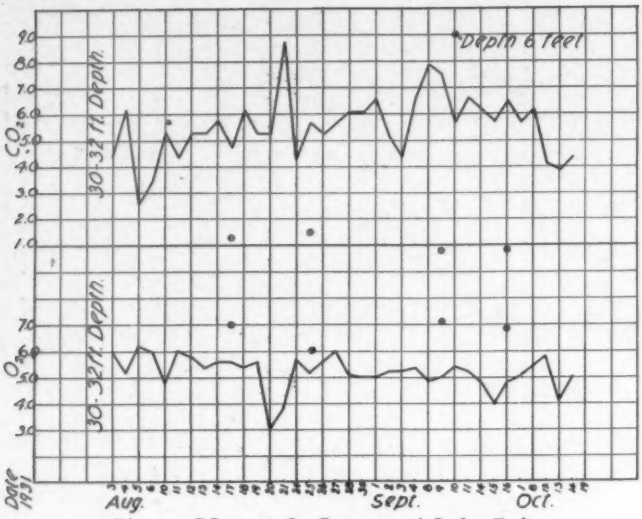

Fig. 4—CO_2 and O_2 Content of Lake Enka

sary to add more coagulant when the manganese in raw water increased than during the periods when it was relatively low.

The jar scale tests were reproduced on a plant scale with astonishing results. The filter time increased 20 per cent to 30 per cent. Floc formations were larger, having a greater density, and the settling basin appeared to be clearer.

The manganese in the raw water at this time was 0.7 mg. per liter and in the clear filter effluent 0.00 to 0.02 mg. per liter.

The filter plant dosage for alum, soda, aluminate, $KMnO_4$, and Cl for December, 1930, was as follows:

Alum	2.83 grains per gallon
Soda Ash	1.43 grains per gallon
Aluminate (commercial liquid)	0.22 grains per gallon
$KMnO_4$	0.04 grains per gallon
Chlorine	1.5 parts per million

With these dosages we were able to precipitate 0.7 to 1.0 mg. per liter of manganese from the raw water and also to maintain 15 to 20 hour filter runs.

In the spring of 1931 the manganese gradually disappeared from the raw water taken into the fllter plant, and consequently an entirely different dosage was necessary later.

TABLE II—COMPARATIVE ANALYSIS OF FILTER SAND—FILTER No. 3

	Appearance	Per Cent of Moisture	MN	FE
After Washing—Aug. 27, 1931				
Surface	Black	30.73	1200.0	312.50
2 in. deep	Blackish Brown	8.48	450.0	156.25
8 in. deep	Blackish Brown	15.90	400.0	156.25
12 in. deep	Dark Brown	33.00	450.0	156.25
18 in. deep	Dark Brown	33.00	450.0	156.75
Before Washing—Oct. 12, 1931				
Surface	Black Mixed with Red Mud	37.96	4000.0	900.0
2 in. deep	Blackish Brown	23.11	800.0	225.0
8 in. deep	Blackish Brown	24.67	700.0	200.0
12 in. deep	Dark Brown	7.42	500.0	175.0
18 in. deep	Dark Brown	5.84	700.0	175.0
After Washing—Oct. 12, 1931				
Surface	Dark Brown	9.15	1200.0	450.0
2 in. deep	Dark Brown	7.91	1000.0	450.0
8 in. deep	Brown	10.92	700.0	450.0
12 in. deep	Brown	11.29	600.0	250.0
18 in. deep	Brown	10.40	600.0	250.0

Manganese and Iron content recorded in p.p.m.

Reservoir Bleeding

In order to decrease or to prevent the accumulation of manganese in the reservoir during the summer and fall of 1931, a valve which drains the lowest portion of the reservoir was opened from time to time and analyses were made to determine the concentration of manganese, iron, carbon dioxide, dissolved oxygen and turbidity. Upon these analyses decisions were made as to the proper time to open this valve.

Notwithstanding the opening of the valve at the bottom of the lake at definite intervals the iron content, particularly, increased during the hot season. From the high manganese content, as given in Fig. 1, we have also come to the conclusion that during 1931 the dissolving action on manganese was probably greater than during 1930. At the beginning of October the manganese near the bottom of the lake decreased sharply and at the same time there was an increase of impurities of the top layers, as shown in Fig. 2.

The same phenomenon may be followed when looking at Fig. 4, in which the turbidity of the bottom and of the top strata of the lake has been plotted. It may be seen that at the beginning of October the marked difference between these figures suddenly disappeared and indicates that mixing had occurred through decrease in temperature of the top layers and the resulting turnover.

As a result of the procedure of drawing water from near the bottom of the lake, our troubles this fall are not serious, as only 0.35 p.p.m. of manganese is present in the mixed lake water, whereas last fall we had to deal with more than double this quantity.

Analyses of sand from the filters indicated that 70 per cent to 80 per cent of the total manganese in the filter sand to a depth of 8 in. may be found within 2 in. of the surface. (See Table II.)

The theory that the phenomenon of the solution of manganese is the result of the decomposition of organic vegetable matter has been well confirmed by our analyses and results as shown. Such decomposition consumes the dissolved oxygen near the bottom of the lake, liberating carbon dioxide and, perhaps, hydrogen sulphide instead. Conditions which fit in nicely with this explanation were actually observed near the bottom of the lake. (See Fig. 4.)

By continuous drawing off from the bottom of the lake during the summer and early fall, it is hoped that after a few years only a small amount of manganese will remain.

Acknowledgment.—Extracts from a paper read before the North Carolina Water and Sewage Works Association, Nov., 1931.

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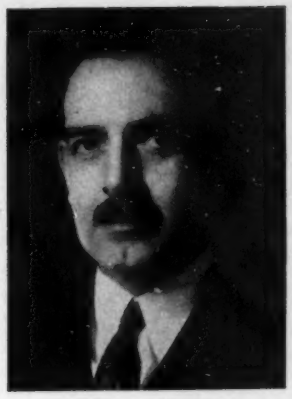
Seattle, Wash., Plans Metropolitan Sewerage District.—The first step has been taken toward establishing a Metropolitan Sewer District at Seattle, Wash., to serve the City and Suburban districts. E. French Chase, Sanitary Engineer in Charge of Seattle Sewers and President of King County Planning Committee, has urged that an appropriation of $50,000 be made by the county commission for financing an immediate preliminary survey. This proposal has been endorsed by local chapters of the A. S. C. E., A. I. E. E., A. I. M. E., A. S. M. E. and other technical Associations. The project has also been endorsed by the county engineer and the State Board of Health. The system proposed would cost between $35,000,000 and $50,000,000.

J. V. N. Dorr
President Elect
Amer. Inst. Chemical Engineers

CHEMICAL ENGINEERS DISCUSS STREAM POLLUTION AND INDUSTRIAL WASTES



Albert E. Marshall
Chairman of Symposium on Stream Pollution

AT the 24th annual meeting of the American Institute of Chemical Engineers, held December 9th to 11th, at Atlantic City, one entire day was devoted to the subject of stream-pollution and industrial waste treatment problems.

A. E. Marshall, Consulting Chemical Engineer of New York City, in charge of the symposium, made the opening remark that "the public and the press have become pollution conscious and since industrial waste treatment is primarily a chemical-engineering problem it was thought advisable to arrange for the seven papers which were to be presented on the subject."

PAPERS AND DISCUSSION

"The Use and Not the Abuse of Streams" was the title of the opening paper read by **Robert Spurr Weston,** Consulting Engineer, Boston, Mass.

Mr. Weston referred to the recent Supreme Court decisions in the Delaware and Connecticut River cases in which Justice Holmes said of the Delaware River "it is more than an amenity; it is a treasure," and looking at it from that angle, streams should be used without being abused. He described the measures applied in determining the power of streams to assimilate wastes and stated that different degrees of treatment of wastes would be required for different circumstances—a higher degree being required in Summer than in Winter because of the lessened flow and the lower oxygen content of streams in Summer concurrent with the increased rates of oxygen depletion. While it was now possible to treat domestic sewage and many industrial wastes to an extent desired, methods had not yet been perfected for the economical treatment of some of our most damaging wastes. Much research needs to be done to discover a practical solution of the problem and that "each stream must be used for the best interest of all riparian owners and with due regard to the rights and convenience of all."

"The Administrative Control of Water Pollution" —by Thorndike Saville—Chief Engineer, North Carolina Department of Conservation & Development, Chapel Hill, N. C.

In reporting on Mr. Saville's contribution justice can not possibly be done. It must be said that his paper is a masterfully prepared compendium on the subject of world waterways pollution and state and governmental relationship to the subject, means of control, legal aspects, etc., etc. and will constitute a highly valuable document for reference in future investigations, legal actions and statute drafting.

Mr. Saville pointed out that the federal government had had two powerful weapons at its command which gives it indirect but none the less effective control over stream pollutions. One is the Treasury Department Standards which drinking water used on interstate carriers (railways, steamships, etc.) must meet and streams used for water supply can not be polluted to a degree that water purification plants will not safely produce from the water a product meeting these standards. The other is the control over the shellfish industry which in turn has resulted in treatment of wastes to render them harmless when emptied into shellfish growing waters.

In discussing combined efforts toward control of streams, from aspects of conservation as well as pollution, Mr. Saville ventured four suggestions of administrative setups. The first would be that of placing entire streams and their watersheds under a water policy commission: the second would be the establishment of rivers boards such as now function very satisfactorily in England and Germany. Such boards would be subsidiary organizations to the water policy commissions. The third suggestion is the creation of a federal water policy commission with powers over purely inter-state matters and the fourth is the expansion of the U. S. Public Health Service work in water pollution activities. The final suggestion was that the American Institute of Chemical Engineers and the American Society of Civil Engineers establish a joint committee whose duty it would be to publish reports on developments in industrial waste treatment and to coordinate the many activities going forward now and later in that field. This in turn would prevent duplication of effort in certain directions. This committee, Mr. Saville thought, should also study the administrative control of water pollution from a national standpoint.

Geo. L. Seabury, Secretary of the American Society of Civil Engineers, replied to President Olsen's request that he give his opinion on the feasibility of a joint committee along the lines suggested by Mr. Saville. Mr. Seabury said that the A.S.C.E. would like to cooperate with the A.I.C.E. and that the establishment of such a committee seemed to be a practical idea susceptible of attainments. He had felt that civil engineers needed the help of chemical men in sewage and waste treatment problems more now than ever before.

[*Editor's Note.*—In business session the following day the A.I.C.E. voted to act favorably on the proposal of

setting up a joint committee with members of the A.S.C.E.to study and report on stream pollution and waste disposal matters.]

"The Sanitary Conservation of Streams by Cooperation" was the subject reviewed by W. L. Stevenson, Chief Engineer of the Pennsylvania Department of Health.

Mr. Stevenson outlined the various methods employed to bring about improved stream conditions in this country, and in Pennsylvania in particular. Cooperation between state agencies having jurisdiction over streams and industry polluting them had been had during the past eight years in Pennsylvania and that from practical experience it had been demonstrated that this "cooperation" constitutes the most satisfactory method of procedure. Specific instances and "agreements" were cited to show how progress in stream cleansing had advanced in Pennsylvania and elsewhere—notably in Pennsylvania. Unfortunately he had found, however, that there were some municipalities and industrial concerns which would not cooperate and police power of the state must need take the place of the constructive work of the engineer. Mr. Stevenson referred to the tanning industry in Pennsylvania having spent $61,000 during 6 years of cooperative endeavor with the state sanitary water board to solve its waste disposal problems. In that same period the joint endeavors had cost the state $29,000 and they at present were studying the streams to determine what degree of treatment of the wastes entering the various streams would be required. Mr. Stevenson explained: "As a start, only the first step in treatment will be installed so that its success can be determined or changes made, if need be, before proceeding with the next steps in the treatment." Similar agreements have been drawn with various other industrial groups in the state of Pennsylvania.

"Stream Pollution in the State of New Jersey" was the topic covered by Dr. Willem Rudolfs of New Brunswick, N. J.

Dr. Rudolfs said that from his calculation the streams of New Jersey must supply 750,000 lb. of oxygen daily to meet the demands of sewage and wastes discharged into them. He questioned the fairness of burdening the tax payer with the cost of treating industrial wastes in municipally operated treatment works. He had found the "measuring sticks" used in evaluating the strength of domestic sewages and their effects on streams totally inadequate and sometimes actually faulty when applied to industrial wastes; that treatment and proper disposal of the latter required specialized knowledge which in many instances does not yet exist. Experimentation toward the development of practical treatment processes belonged in the realm of the industry rather than in outside agencies such as pollution boards, health departments, etc. He thought the latter might, however, assist in solving the problems. The volume of industrial wastes discharged into New Jersey streams is considerably in excess of 200,000,000 gal. daily. Dr. Rudolfs believes that research will be required to solve the numerous problems—and this within the industry itself. Unfortunately at the present time there exists no efficient measuring device, such as is applicable in sewage treatment, to foretell to what degree most industrial wastes should be treated and there is need for much study of the whole problem.

"Work of the Connecticut State Water Commission" by W. E. Wise, Engineer of the State Water Commission, Hartford, Conn.

Mr. Wise said that the State Water Commission in Connecticut, organized in 1925, was authorized to order the correction of pollution of its streams, but in doing so, according to the law, it must at the same time **prescribe the means by which the desired result can be accomplished.** That requirement had necessitated much chemical and engineering research by the commission. The investigations made to date on the treatment of ferrous wastes were reviewed—one of the interesting points being that ferrous iron in acid pickle liquors had been only slowly precipitated by limestone whereas after oxidization the iron is rapidly and completely precipitated. Other waste treatments discussed were those applicable to brass working plants, kier liquors from bleacheries and other textile plants, tanneries, laundries, wool and felt mills and others. In their work with treatments employing chemical precipitation they had concluded that the fill and draw method would be more workable and dependable for small plants than the use of continuous flow tanks. The irregularity in rates of discharge and quality of wastes had made the use of the fill and draw scheme preferable usually.

Mr. Wise, in his concluding remarks, stated that it appeared hopeless to expect that profit could be derived in treating most industrial wastes and that manufacturers must clearly recognize their responsibility in improving stream conditions regardless of the fact that the treatment might increase production costs somewhat.

In discussion it was brought out that the Connecticut State Health Department functioned in cooperation with the State Water Commission to avoid duplication of efforts and possible clashing of interests. It was also developed that the Connecticut Commission is the only anti-pollution agency in America that is required by law to prescribe a method of waste treatment for the industry. It was also brought out that having provided impounding tanks the continuous flow method of waste treatment would prove just as effective as the fill and draw method.

"Disposal of Starch and Beet Sugar Plant Wastes" by Professor Edward Bartow, Department of Chemical Engineering, University of Iowa, Iowa City, Ia.

Professor Bartow reviewed the accomplishments in disposal of wastes from starch and beet sugar factories. He had found that "charity begins at home" so to speak and that much could and had been accomplished within the factories by process changes and alterations to conserve valuable products formerly discharged in the liquid wastes. In the end there would be some very dilute wastes to be disposed of by processes most suitable to the circumstances but that it was practical to treat these dilute wastes in part at least and to return the clarified water to the factories for reuse in certain operations. Beet sugar wastes had in part been so handled, but the Steffen's waste remained as quite a problem and is now under study at several points. In closing Professor Bartow emphasized the desirability of reducing the waste problem by keeping much of the now wasted material within the plant and out of the sewer and in addition the possible recovery of values from the wastes not formerly appreciated as worth

consideration. Any other procedure in solving waste problems he considered to be very poor business.

A. E. Marshall stated that glutamic acid is being made from Steffen's waste in American and is shipped in considerable quantity to Japan where it is used as a condiment but that there was not demand enough to take care of more than a small part of the Steffen's waste available.

E. B. Besselievre of The Dorr Co. presented an illustrated paper prepared by himself and **Anthony Anable,** of the same firm, which dealt with **"Liquid Wastes from Industrial Plants and Their Treatment."**

In their paper specific examples of methods and the equipment employed in treating various industrial wastes were covered. Mr. Besselievre made the warning statement that experience had shown that as simple as waste treatment might seem at first glance, many a concern has been led to embark on waste treatment projects without competent counsel and with the result that the procedure had proven both costly and inadequate. He enumerated the more important considerations to be taken into account when undertaking a program of waste treatment and said that the cost of reclaimed products from wastes were generally greater than the market price of the same materials, and that as a governing principle the problem of waste treatment should be viewed as a remedial one without expectation of profit. Money spent for procuring expert advice and counsel in waste disposal programs will be repaid by securing a satisfactory solution of the problem in a way which will be commended by administrative authorities.

C. M. Baker, Engineer, American Pulp & Paper Association said that he believed that the proper solution of stream pollution lay in the industry's hands largely and much could be done to curtail waste of products now going to the sewers. His own industry had benefited in that method of procedure and now paper making materials in numerous instances were recovered by the return of "white-water" for re-use in the process. One mill had made a capital expenditure of $41,000 and now returned to the system $100,000 worth of fibre annually that had been going to the sewer: the water was being reused over and over again. He believed that after the industry itself had reduced waste to an economical minimum by recovery processes then the residual waste requiring treatment in some form might well be handled by the state and industry jointly. His experience had indicated that the matter of stream pollution could best be handled by the engineering staffs of state departments of health, as the controlling body, rather than by other agencies.

The largest problem facing the pulp and paper industry remained, as always, the waste liquors from the sulphite pulping process in which one-half the weight of the original wood is contained. The use of sodium sulphite rather than calcium sulphite in pulp production would possibly be the ultimate answer. In this case the soda is recovered by evaporation and burning or cintering of the waste liquor and little or no waste enters the streams.

Sheppard T. Powell, Consulting Chemical Engineer of Baltimore, Md., spoke briefly concerning the influence on processes and economic losses caused by industrial wastes contaminating the water supply used in the same plant which had polluted the water-way. Especially had this been noticed in stream condensers at power plants. It could be shown that attempts to treat trade wastes in municipal sewage works was not sound practice economically. Mr. Powell stressed the observation that streams seem to be getting in a progressively worse condition nothwithstanding efforts made and the improvements reported by some State Authorities. Cooperation is of course desirable, but more intensive efforts are badly needed.

Robert Spurr Weston, of Boston, added that the stream condition was paramount and recovery of secondary importance in stream cleansing programs. He thought that setting up of river boards had promise but that in the end the departments of health are the proper agencies to carry on stream pollution control work. River boards might be organized by the state health department to function as a subsidiary agency.

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Taxes and Brotherly Love

The proposal of the council to increase water rates by 50 per cent and real estate taxes by 20 per cent recently met a stormy defeat in spectacular fashion at Philadelphia's City Hall.

A crusade of citizens*—(beginning as a parade of 300 and swelling to between 10,000 and 15,000)—founded on determination that taxes and water rates should not be increased, reached its climax in a demonstration of protest staged at City Hall on Dec. 11. The outcome was a complete rout of the council and the increases in water rates and taxes were voted down.

The outcome of no increases necessitates the lopping off of $13,000,000 from the city's budget for 1932. This cut is now to be accomplished by a 33 1/3 per cent reduction in the city payroll and corresponding slashes in maintenance and supply appropriations. This will result in a material reduction in number of employees together with salary reductions in some quarters.

More recently Philadelphia found itself unable to pay 25,000 of its employees the semi-monthly salaries due Dec. 15 and banks refused to loan the needed $1,700,000. Recourse has been taken to a round-about way of raising cash, viz.—through the purchase by the city of some of its own unsalable bonds, using sinking fund money for the purpose.

Mayor Mackey makes the press statement that the present situation "is an accumulation of bad financing, the ignoring of all signs along the way and the forcing (by council) of larger budgets upon my directors for three of the four years and short-changing the budget of 1931."

As if by other than mere coincidence, on this day of demonstration against increased water rates a very pronounced taste of chlorinated-phenols appeared in Philadelphia's water which was reported to have come from the Delaware River supply.

*See front cover for photograph of the demonstration staged at City Hall—Courtesy Philadelphia Record.

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LANCASTER, O., TO INSTALL ZEOLITE WATER SOFTENING.—Chas. P. Hoover, Chemical Engineer of Columbus, O., has been retained by the City of Lancaster (Walter Groff, City Engineer) to draw up plans and specifications for a water softening plant. The Zeolite process will be used.

FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor
Physical Chemist, Bureau of Engineering, Chicago, Ill.

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THE USE OF CHARCOAL AND ACTIVATED CARBON IN WATER TREATMENT

Part 4: Present Use of Activated Carbon in Water Treatment

THE early history of the use of charcoal in water treatment, and a discussion of the development, manufacture and characteristics of activated carbon have been given in previous articles. This article will deal largely with the use of activated carbon at the present time. It was stated in the first article of the series that even though there have been attempts to use charcoal and bone char in municipal water plants years ago the materials used at that time did not prove successful. Bone char has been used in small filters for perhaps a hundred years, and many such filters will be found at the present time in localities where the water is not filtered, or where the water after filtration is not very palatable. One type of such filter used quite extensively for homes has a hollow stone filled with bone char. The water passes through the stone for clarification, then through the granular carbon. The writer has interviewed a few who have used such filters, and they report that they are very successful if the bone char is changed fairly often.

It is not the purpose of this article to discuss household or other small filters, and the use of bone char within recent years is mentioned largely because such filters have served to keep the public acquainted with the purifying qualities of such materials. No water works will meet with objection from the public to the use of animal or vegetable charcoal, for the public has heard of the purifying qualities of charcoal. Objections to the chemical treatment of drinking water have almost disappeared, and the advantage of using something that meets with public favor is not so great now as it would have been some years ago. It is believed, however, there is no expenditure the water works may make that will receive more ready approval by the public than the use of activated carbon for improving the taste of the water.

Beginning of the Use of Activated Carbon in Water Treatment.—The use of lignite, both raw and carbonized, by the Candy Filter Company of England for dechlorination 20 to 15 years ago did not attract much attention, though the process is reported to have been successful. Watzl[1] states that the De-Chlor Process has been used by the Royal Borough of Windsor, Reading, Southcote, Truro, Monmouth, and Newport, England. He reports receiving an official communication from the Borough of Reading dated June 27, 1928, stating that: "The filters at Southcote are still in active operation and . . . that their efficiency is unimpaired after 18 years continued working." Truro, according to Watzl, has used the De-Chlor Process since 1911. The Candy Filter Company later patented the use of raw lignite,[2] stating that it was more effective for dechlorination than the carbonized material.

Probably the next attempt to use carbon for dechlorination was by Oscar and Rudolf Adler, of Karlsbad, Czechoslovakia. They applied for a patent on the process in Czechoslovakia, July 15, 1925, which was granted June 13, 1927. Patents have now been granted to the Adlers in England[3] and the United States[4] on their process of treating water. They superchlorinate the water and then dechlorinate it by passing the water through a bed of active carbon. The main claim in their patent is that the carbonized materials used prior to their invention adsorbed the chlorine ions and soon became saturated with the adsorbed ions and would no longer remove the free chlorine from water, unless the carbon was treated in some manner to remove the adsorbed chlorine; whereas the active carbon they use converts the chlorine to hydrochloric acid and continues to be effective as a dechlorinating agent for a long time. The writer has proven quite conclusively in experiments which have not as yet been published that carbonized materials similar to those used years ago for dechlorination does convert the chlorine to hydrochloric acid. Regardless of whether the Adlers can sustain their patents, it is evident that they done much to again start interest in the use of carbon for water treatment in Europe.

R. Adler,[5] in 1928, described their process of purification and sterilization of water. A large amount of chlorine will result in completely sterile water and will result in the removal of organic matter, iron and manganese. The excess chlorine may be removed by passing the water over active carbon which converts the residual chlorine to hydrochloric acid. From time to time the carbon must be washed with water containing sodium carbonate to remove the organic materials.

Dr. Adler visited the United States in the summer of 1927 and was able to induce the city of Cleveland, O., to make some tests in August and September of that year on his process, using a small dechlorinating equip-

ment. To obtain more specific information on the possibilities of carbon for chlorine and phenol removal, the city of Cleveland constructed a small experimental plant at the Baldwin Ave. filtration plant, reported to have a capacity of about 300,000 gal. daily. The plant was operated under the direction of Joseph W. Ellms. It was put in operation in February, 1928. Most of the materials used were prepared from anthracite coal, peat, paper mill sulphite wastes, synthetic bone char, and activated coconut char. The Cleveland work was never published, though it is generally known that Mr. Ellms did not recommend the use of carbon for Cleveland. The experimental work at Cleveland was carried on quite actively during 1928 and the early part of 1929.

Watzl[1] read a paper before the Water, Sewage and Sanitation Division of the American Chemical Society held at Swampscott, Mass., Sept. 13, 1928, on "Superchlorination and Subsequent Dechlorination Over Carbon for Municipal Water Supply." He termed his process the "American De-Chlor Process." Watzl suggested that the rate of passing the water through the carbon beds may be as high as 12 times that of customary rapid sand filtration rates. To the writer, it seems evident that such a high rate would not give satisfactory results and is not the most economical means of utilizing activated carbon in water purification plants.

Credit should be given to the officials of the Cleveland water purification plant for the pioneer work in this country on the use of activated carbon for the removal of chlorine and phenol from water. It is not believed, however, that the Cleveland work would have attracted sufficient attention to start the use of activated carbon in this country had no other work been undertaken.

The Chicago Experiments.—Chicago, in December, 1927, experienced probably the most disagreeable chlorophenol taste in the drinking water that has ever occurred in a large water supply. This was a few months before the Chicago Experimental Filtration Plant was put in operation. Work was under way in the laboratory on filtration experiments and on methods for making quantitative phenol determinations at the time the very disagreeable chlorophenol taste occurred. No effort was made at that time to find a method of removing the phenol, but accurate measurements of the amount of phenol that was in the water were made. While the taste was still quite pronounced, a newspaper report from one of the chemists of Swift & Company stated that the taste could be removed by adding charcoal to the water.

Shortly afterwards we began to give consideration to methods of removing phenol from water. Charcoal was added to a sample of water containing phenol with considerable improvement in the taste. Due to details of getting the experimental plant in operation, experiments on the use of charcoal for phenol removal were not started very actively until March 6, 1928. Wood charcoal, not activated, was added to a glass tube about 1⅝ in. inside diameter to make a bed about 24 in. in depth. Water containing 0.045 p.p.m. of phenol was passed through the bed of material at about 2 gal. per square foot per minute. The first few liters that passed through the bed had the phenol reduced to 0.004 p.p.m., but the amount in the filtrate gradually increased, until after a month of service the amount removed by the charcoal was only about 60 per cent.

It was then decided to try other carbons, and the glass tube unit was filled to a depth of 24 in. with a mixture of bone char and Hydrodarco. The reason for mixing the two materials was that we did not have sufficient of either on hand to fill the tube to the desired depth. Experiments with this unit were started June 1, 1928, passing water through the bed of carbon that contained 0.100 p.p.m. of phenol. The phenol was removed completely, even though the concentration of phenol was increased quite materially as the test continued. On June 14, 1928, the writer visited Cleveland and was told that they were investigating activated carbon for chlorine and phenol removal. This is the first he was aware of other experiments on active carbon being under way. Up to this time the writer had not given thought to the use of active carbon for dechlorination.

The writer's experiments on removing objectionable taste-producing substances from water with active carbon were very encouraging, and were made more extensive. As soon as the glass tube units indicated that active carbon had possibilities in water treatment for taste and odor removal, a larger unit (10 sq. ft. surface area) was put into service, Dec. 28, 1928. This unit was capable of passing 28,800 gal. of water per 24 hours at a rate of 2 gal. per square foot per minute, and was regarded as being large enough for reliable experiments. The writer already has published two articles[6] on the experiments which have been under way on active carbon. It is believed that publication of the first article in June, 1929, was largely responsible for stimulating interest in the use of activated carbon for taste and odor removal in the United States.

Use of Activated Carbon in Europe.—Experimental work on the use of activated carbon, other than promotion of the Adler patented process, appears to have been started in Europe about the same time experiments were started in America. An article in *Water and Water Engineering,*[7] September, 1930, states that: "More than two years ago, Dr. Sierp, of the Rhur Union, and Mr. Heinz, the director of the Hamm waterworks, carried out laboratory experiments with the object of getting rid of the unpleasant taste of chlorophenol. The small scale experiment turned out so favorably that they went on to experiments on a practical scale, which were so successful that it was decided to purify the whole of the drinking water of the town of Hamm with active carbon. Early last year an active carbon filtration plant was installed." The capacity of the Hamm plant is about 25,000 cubic meters, or about 6.6 million gallons daily. The filter contains about 6 tons of "Hydraffin II," a product manufactured by the Carbo-Norit-Union. Operation of the Hamm plant has been described by Imhoff and Sierp.[8]

The writer wishes to state that his information on the use of activated carbon in Europe is quite meager, and the few references given probably cover only part of the places where activated carbon has been tried. Krob and Gruschka[9] describe the new Elbe water plant at Aussig. This was one of the first plants to use the Adler system of high chlorination followed by dechlorination by passing the water through beds of active carbon. The addition of alum or iron sulphate is followed by chlorination and settling, and the water is then filtered through rapid and slow sand filters. The water is again chlorinated and passed through Depurit active charcoal filters. The charcoal is regenerated with soda ash [Na_2CO_3] solution at monthly intervals, and by occasional steaming. Water treated in this manner has no taste, color or odor.

Sartorious and Ottemeyer[10] describe interesting experiments on the removal of disturbing substances in drinking water by activated and unactivated carbon at the Westphalian Wilhelms University. Experiments were conducted in tubes 3 cm. in diameter and about 1

meter long. The depth of the layer of carbon particles was about 20 cm., and the flow took place in an upward direction. Wood charcoal, coke, and activated carbon were tried. All three kinds of carbon showed the ability to remove chlorine; coke the least, simple charcoal much more, and activated carbon tremendously. Regeneration of the saturated carbon by means of steam was easily and completely accomplished in the case of charcoal, partly in the case of coke, and to a considerable extent in the case of active carbon. The removal of phenol and chlorophenol is very much harder than dechlorination. Charcoal and coke have no effect worthy of note, but activated carbon is effective.

Link[11] gives an account of the use of active carbon in the water supply at Stuttgart. Part of the supply used as a peak-load and emergency source is highly polluted. High chlorination is used to insure sterilization. After filtration an Adler Mutonator (active charcoal filter) is used to remove the excess chlorine and chlorine compounds. Chlorinated sodium carbonate solution is used to regenerate the charcoal, and this is followed by a treatment with calcium chloride. Link also describes the Adler-Diachlor-Mutonit process of high chlorination to utilize the oxidizing and decomposing powers of the chlorine to remove iron, manganese, humic substances, and substances causing odor, taste and color. The water is then dechlorinated with carbon.

So far as is known very little powdered activated carbon has been used for water treatment in Europe.

Use of Beds of Active Carbon in America.—At the present time only two municipal water supplies have beds of activated carbon for taste and odor removal—Bay City and Dundee, Mich. The plant at Bay City filters several million gallons of water daily. The sand was removed from one of the filters and it was filled with 24 in. of Hydrodarco. When the filtered water has a taste it is pumped through the Hydrodarco unit. Harrison[12] states that the plant is working satisfactorily.

The plant at Dundee, Mich.,[13] is a small water softening plant. The water from the clear water reservoir is pumped through a bed of Hydrodarco before going to the distribution system. The Hydrodarco unit is located on the pressure side of the pumps somewhat like a pressure filter. The rate of passing the water through the carbon unit is fairly high, and it probably would not take care of very highly polluted water.

There are a number of active carbon units in use in private plants where it is essential to have very palatable water. Hotels, restaurants, bottling plants, canning plants, and other such plants frequently use carbon beds for improving the taste of the water where the municipal supply is not always palatable. It seems evident that the use of beds of granular carbon will increase quite materially as soon as it has been demonstarted that the cost is not excessive. So far the only bed of granular carbon that has been run under ideal conditions over a fairly long period is a bed of Hydrodarco at the Chicago Experimental Filtration Plant. This bed had been in continuous service for 3 years on the 28th of December, 1931. Sixty-five thousand gallons of water per pound of carbon had passed through the bed up to the end of the 3-year period. The Chicago water is not highly polluted with taste-producing compounds, but the water at the experimental plant is frequently artificially polluted with waste products from certain types of industries and this has thrown a load on the carbon unit in excess of what it would have had to handle naturally. The bed is still effective, though it is believed to be nearing the point where it should be revivified.

Norcom and Dodd[14] report a very interesting series of experiments on the use of activated carbon in removing tastes and odors from the Delaware River water at Chester, Pa. The odors most frequently encountered were caused by oil refineries, paper mills, chemical plants, and organic matter of domestic origin. Small filters of 4-in. glass tubing and 8-in. cast iron pipe were used. The beds of carbon were 30 in. in depth. Granular Nuchar, Darco and Minchar were used in the experiments. Best results were obtained with Darco—(now known as Hydro-Darco). Norcom and Dodd state that under the conditions of the experiments it appears that a 30-in. bed of Darco operating on filtered water at a rate of 2 gal. per square foot per minute will remove all appreciable odor for about one year without regeneration. The passage of steam through beds of Darco and Nuchar so as to maintain a boiling temperature for about ½ hour will remove a quantity of the substance which has been adsorbed by the carbon.

Goudey[15] has experimented with the use of activated carbon on reclamation of treated sewage at Los Angeles, Calif. After the sewage has gone through the usual sewage treatment process the water is superchlorinated, coagulated with ferric chloride, passes through settling basins, and is then filtered with very coarse grained sand filters and passed through a bed of Darco (Hydrodarco). The final product compares very favorably with the Los Angeles aqueduct water.

Behrman and Crane[16] have given consideration to the mechanical handling of granular activated carbon. They show that the carbon units may be placed underneath the sand filters if desired, producing what may be called a 2-story filter. This takes up the least space and probably is the cheapest arrangement of the carbon units. They also show that if there is a space of 8 to 10 ft. underneath the filters, as is often the case, the carbon units can be located underneath existing filters.

Use of Powdered Activated Carbon.—Decidedly the most extensive use of activated carbon in water treatment in America at the present time is in the powdered form. Spalding[17] was the first to use the powdered material. He presented a paper before the New York Section of the American Water Works Association in May, 1929, describing laboratory experiments on the use of powdered Nuchar in removing fishy and swampy odors, and in removing phenol and aldehol. In a supplementary note, Spalding states that No. 2 Nuchar was used in the plant of the Hackensack Water Co. at New Milford, N. J., over a period of 23 days during March, 1930. The raw water contained an odor characterized as distinct fishy due to asterionella, dinobryon and uroglena. 1.2 parts per million of the Nuchar removed the odor entirely. The carbon was applied to the coagulant mixing chamber through a chemical dry feed machine with ejector discharge.

The successful use of activated carbon by the Hackensack Water Co. for taste and odor removal led others to try the powdered material. Stern[18] set up a miniature rapid sand filter in the laboratory of the Hamburg, N. Y., filtration plant and experimented with powdered activated carbon for removing tastes and odors produced by micro-organisms. He found that the powdered material was effective in removing objectionable tastes, and that the amount required was very small. The carbon was then used in the plant, being applied directly to the filters. About 1.5 p.p.m. was effective in removing a musty taste which was thought to be due to spirogyra. Stern states that since powdered car-

bon costs so little it is being applied continuously to the water, even though there was no persisting unpleasant taste in the water.

Trowbridge[19] used powdered Nuchar to remove phenol from the South Pittsburgh Water Co.'s supply when there was an accidental spill of phenol into the Monongahela River by a by-product coke plant in October, 1930. Samples of the water at the intake showed that phenol was present for several days, while the effluent of the filtration remained free from taste and odor. The powdered activated carbon was added to the raw water, and the water was then coagulated and filtered in the usual manner. Trowbridge stated that Nuchar for taste and odor removal has been tried in six of the plants of the American Water Works & Electric Co. during recent months. Experiments at the city of New Castle Water Co. indicated that less carbon was required by applying it to the water as the water goes to the filters. The use of 2.6 p.p.m. of Nuchar produced water free from taste and odor.

Pirnie,[20] in reviewing present experience with powdered activated carbon at 15 plants, states that the popular method of applying the powder is to run it through a dry feed machine into a hopper where water is added and a water eductor picks up the mixtures and forces it through a pipe or hose to the point of application. The material is applied at various points in different plants from the raw water pump suctions to the water on top of the filters. Pirnie believes that the most intimate contact between powdered activated carbon and the water can be secured by adding the carbon to the applied water at some point between the coagulation (settling) basins and the filters. In discussing Pirnie's paper, Stuart gives a resume of the use of Nuchar in several plants. 0.7 p.p.m., costing 30 cents per m.g., was used at Hamburg, N. Y.; 3.3 p.p.m., costing $1.35 per m.g., was used at New Castle, Pa.; 0.8 p.p.m., costing 39 cents per m.g., was used at Olean, N. Y.; 1.6 p.p.m., costing 78 cents per m.g., was used at Washington, Pa.; and 1.7 p.p.m., costing 70 cents per m.g., was used at Morgantown, W. Va.

Fitzgerald[21] describes the use of powdered Nuchar at Norfolk and Newport News, Va. Attempts to remove the taste and odor caused from algae at Norfolk by heavy prechlorination, aeration, and ammoniation of the raw water, were not completely successful. 1.5 parts per million of carbon, costing 62.5 cents per million gallons, removed the taste and odor. At Newport News it became necessary to take water from a lower level of the storage reservoir, and this water had a very disagreeable taste and odor. 1.7 parts per million of carbon added to the water just prior to filtration removed the taste and odor. The cost of the treatment was about 70 cents per million gallons. The treatment at Newport News has been described more in detail by Dugger.[22]

Waring[23] gives a list of 31 cities which have tried activated carbon for taste and odor removal. He states that the Ohio River Board of Engineers (comprising the chief engineers of the State Health Department in the eleven Ohio River states) recommended that every Ohio River filtration plant should be equipped for both the ammonia-chlorine treatment and activated carbon treatment in order to successfully cope with possible phenolic or other taste producing substances present in the Ohio River water.

The writer is reliably informed that more than 150 water treatment plants in the United States have used activated carbon during periods of bad tasting water, and that a few of the plants are using powdered carbon regularly whether the water does or does not have an objectionable taste.

The Future for Activated Carbon.—The use of activated carbon for removing objectionable tastes and odors from water at the present time indicates its extended use in the future, unless some cheaper and simpler means of removing tastes and odors is found. Just as soon as it was known that activated carbon would remove chlorinous tastes and tastes made more pronounced by the addition of chlorine to the water, it was found that ammonia could be used to prevent such tastes. This has eliminated the need for using active carbon in waters where chlorinous tastes only were the cause of complaints. It is believed that considerably more than one-half of the public water supplies which come from surface sources have objectionable tastes and odors of natural origin occurring often enough to justify treatment of the water for their removal. It is in these plants that activated carbon very likely will be used quite extensively in the future.

The fact that active carbon is effective in removing almost any kind of taste and odor likely to be present in water should make it particularly attractive for water works use. It is safe to say that active carbon in water treatment has come to stay, and that its use will increase rapidly. Filtration plant operators who fail to make use of some effective means of eliminating objectionable tastes and odors when they occur are negligent of the wishes of the water consumers. In some instances money may not be available for taste elimination, but such instances are believed to be very few. The failure to properly treat water for its clarification and palatableness merely to save in operating cost is the kind of economy the people do not want.

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Four States Section A.W.W.A. Meets in Philadelphia

On Dec. 11th, the Four States Section of the A. W. W. A. held a luncheon meeting at the Bellevue-Stratford Hotel in Philadelphia at which Chairman L. Van Gilder, Engineer-Superintendent of the Atlantic City Water Department presided. Arrangements were in charge of Secretary Chas. H. Becker and eighty-five attended.

After the luncheon H. S. R. McCurdy, Chief Engineer of the Philadelphia Suburban Water Company, presented an illustrated paper describing "The Springton Dam and Reservoir on Crum Creek," which is one of the several sources supplying the purification works of the company.

The dam, completed in the Spring of 1931, is of the earth fill type with a concrete core wall—having a concrete spillway at one end. The discussion which followed revolved around the features of rip-rap work on the slope of this and other dams.

The next annual meeting of the Four States Section will be a two-day meeting to be held at Atlantic City, N. J., during the latter part of May or early in June—a definite date to be decided.

The following were present at the Philadelphia meeting:

Members and Non-Members at Meeting of Four States Section

Angell, J. M., Jr., Water Works and Sewerage, New York, N. Y.
Beckwith, H. E., Pitometer Co., Harrisburg, Pa.
Birkinbine, C. P., Consulting Engineer, Philadelphia, Pa.
Birkinbine, John L. W., Philadelphia, Pa.
Brewer, Glenn, Atlantic County Water Co., Pleasantville, N. J.
Briggs, H. J., Philadelphia, Pa.
Brooks, John N., N. J. State Water Policy Com., Trenton, N. J.
Bruce, C. J., Evitts Creek Water Co., Cumberland, Md.
Burnstein, Maurice, Water Department, Atlantic City, N. J.
Bureau N. V., Philadelphia, Pa.
Conard, W. A., Burlington, N. J.
Conard, W. R., Burlington, N. J.
Critchlow, N. J. State Water Policy, Comm., Trenton, N. J.
Devilbiss, H. Roland, Washington Suburban Sanitary Dist., Hyattsville, Md.
Emerson C. A., Jr., Philadelphia, Pa.
Enslow, L. H., Water Works and Sewerage, New York, N. Y.
Feeney, A. J., Water Department, Wilmington, Del.
Fiesler, F. A., Girardville, Pa.
Freeburn, K. M., Department of Health, Philadephia, Pa.
Friel, Francis S., Philadelphia, Pa.
Glace, I. M., State Health Department, Harrisburg, Pa.
Hall H. R., Washington Suburban Sanitary Dist., Hyattsville, Md.
Haydock, Charles, Philadelphia, Pa.
Heine, Bureau of Water, Reading, Pa.
Jenne, Lyle L., Bureau of Water, Philadelphia, Pa.
Jester, J. M., Engineer, Washington Suburban Sanitary Dist., Hyattsville, Md.
Johnson, John Ward, Burlington, N. J.
Kershaw, E. L., Water Company, Shillington, Pa.
Loomis, Russell.
Manahan, Everett C., Wilmington, Del.
McCurdy, H. S. R., Philadelphia Suburban Water Co., Bryn Mawr, Pa.
Reber, Harry C., Angelica Water & Ice Co., Reading, Pa.
Reinicker, L. T., Delaware Valley Utilities Co., Philadelphia, Pa.
Rode, Louis, Supt. of Meters, Wilmington, Del.
Russell, Joseph A., Philadelphia, Pa.
Sigmund, Merle H., Town Engineer, Newark, Del.
Schnabel, Bureau of Water, Allentown, Pa.
Stompler, O. F., Langhorne Spring Water Co., Langhorne, Pa.
Swaab, S. M., Consulting Engineer, Philadelphia, Pa.
Story, I. F., Wilmington Water Co., Wilmington, Del.
Strohmeyer, Jos. S., Water Department, Wilmington, Del.
Tolson, Albert, Supt. of Filters, Philadelphia, Pa.
Trumbone, F. J., Atlantic City Water Department, Pleasantville, N. J.
Van Gilder, Water Department, Atlantic City, N. J.
Van Loan, Water Department, Philadelphia, Pa.
Van Sciver, Harry B., Water Department, Wilmington, Del.
Van Trump, S. N., Wilmington Water Dept., Wilmington Del.
Wagner, Edwin, Water Works, Downington, Pa.
Walker, Isaac S., Consulting Engineer, Philadelphia, Pa.
Weber, John S., Trenton, N. J.
Wertz, C. F., Fuller & McClintock, Philadelphia, Pa.
Weston, R. S., Consulting Sanitary Engineer, Boston, Mass.
Wills, W. C., Deputy Chief Engineer, Wilmington, Del.

Corporate Members

McConnell, F. F., Bethlehem, Pa.
Reichard, William H., Bethlehem, Pa.

Associate Members

Acker, Joseph D., R. D. Wood & Co., Philadelphia, Pa.
Arnold, V. E., Phoenix Meter Corp., New York, N. Y.
Atwell John L., A. P. Smith Manufacturing Co., E. Orange, N. J.
Baker, Charles T., R. D. Wood & Co., Philadelphia, Pa.
Becker, Charles H., R. D. Wood & Co., Philadelphia, Pa.
Buttenheim, Edgar J., *American City Magazine,* New York, N. Y.
Cambridge, W. B., Hersey Manufacturing Co., New York, N. Y.
Case E. D., The Pitometer Co., New York, N. Y.
Canton, E. J., Badger Meter Mfg. Co., Baltimore, Md.
Dawson, F. H., Darling Valve & Mfg. Co., Williamsport, Pa.
Hayes, Jos. A., Neptune Meter Co., New York, N. Y.
Howard A. C., Wailes Dove-Hermiston Corp., Philadelphia, Pa.
Hubley, B. D., Hersey Manufacturing Co., Philadelphia, Pa.
Kinney, J. B., Wallace & Tiernan Co., Inc., Philadelphia, Pa.
Kraft, Fred A., Pittsburgh Meter Co., New York N. Y.
Lame, E. J., R. D. Wood & Co., Philadelphia, Pa.
Mann, Karl M., *Water Works Engineering,* New York, N. Y.
Marshall, William, Mathieson Alkali Works, Inc., New York, N. Y.
McKagne, John J., National Meter Co., New York, N. Y.
McKay, George, Jr., Leadite Company, Philadelphia, Pa.
Noonan, D. F., Badger Meter Co., New York, N. Y.
Pleibel, A. F., R. D. Wood & Co., Philadelphia, Pa.
Sites, K. G., Hydraulic Development Co., New York, N. Y.
Turner, C. D., Wailes Dove-Hermiston Corp., New York, N. Y.
Turner, R. W., Rensselaer Valve Co., New York, N. Y.
Warde, John S., Rensselaer Valve Co., New York, N. Y.
Weir, J. M., Leadite Company, Philadelphia, Pa.
Wirtz, George L., Atlas Mineral Products Co., Mertztown, Pa.
Wood, Alan A., Builders Iron Foundry, Philadelphia, Pa.
Wood, T. V., Leadite Co., Philadelphia, Pa.

METERING:

Practical Methods of Procedure

By E. H. RUEHL

City Manager,
Bluefield, Va.

E. H. Ruehl

"TO Meter or Not to Meter," that is the question.

Those of you gentlemen who have, and I know some have, gone through the problem of making initial installation of water meters in your community know what significance these few words can have and just what discussions can be caused thereby.

However, metered water service is being acknowledged more and more as being the best all around method of distributing th indispensable commodity, WATER. This is especially true since the unprecedented drought of 1930 and I am sure that if more communities were metered at that time the effects of the drought would have been less severe due to the lessened wastage of water.

There are many good reasons why water services should be metered, a few of which are:

(1) It is the fairest way of selling water as all customers pay in proportion to their respective consumptions.

(2) The water department or company has a pretty good check on the amount of water sold and by comparison with readings of a master meter can better establish losses and leakage and thereby reduce waste in the system in general.

(3) Leaks in consumers service lines can better be located.

(4) Knowledge of the various water consumptions is essential in establishing equitable water rates and the only way in which this information can be obtained and analyzed is by metering of ALL SERVICES.

In some cases, especially in the municipally owned plants, there are certain institutions such as schools, hospitals and the like that are supplied with water without charge and these should be metered and read regularly to get the full benefits of 100 per cent metering.

(And here let me digress a little to state that the words municipally owned are generally a misnomer as in the majority of cases the municipality has a large obligation in the form of outstanding bonds and the only part that is really municipally owned is the amount covered by bonds purchased back or some such similar item. This is mentioned here because in the municipally operated plants we are so often confronted with the statement that the people own the plant and for this reason they should have all the water wanted for some flat rate that is nowhere commensurate with the cost of producing the water, the fixed charges being lost sight of entirely.

(5) It has been proven that as meters are installed that consumers' wastes have been reduced and this in turn effects economies in the amount of power required to pump, if it be a pumping plant, and in treatment costs, which are getting higher and higher every day.

(6) As the water requirements of the city are kept within bounds and more or less controlled the size of the treating and pumping plants and storage and distribution systems are kept to a minimum, thereby keeping capital investment to a minimum as well as the necessary interest and sinking fund charges which all result in keeping of the water rates at the lowest possible figure.

(7) As the time will most likely come when sewage treatment will become necessary in a good many places the lowering of the water losses and wastes will redound to the town's advantage in requiring a plant of smaller capacity than would be necessary if water usage and wastage were uncontrolled.

With all these reasons in favor of metering the only ones against it are generally found to be caused by selfish motives wherein certain customers may want to use unlimited quantities of water without paying a just price therefore. This can be overcome in a great many cases by explanation, and in spite of the fact that many may be adamant at first good results are usually obtained.

Another argument against metering is sometimes set forth in that it is claimed that sanitary conditions will not be maintained if water usage be curtailed due to the installation of meters but it has been shown, (and I believe that some of the sanitary engineers present here today will bear me out in this) that for all purposes about 25 gal. per capita per day is all that is absolutely necessary. Under any ordinary rate the cost for this requirement for the average family for an entire month would be modest, in most cases less than the cost of one filling of the gasoline tank of the automobile.

It can therefore be seen that metering is beneficial to both the municipal plant or privately owned company as well as to the consumer, since it contributes a means of compiling equitable rates and keeping bills to a minimum.

Ownership and Location of Meters

The foregoing paragraphs constitute a generalized statement. Since the type of meter and location of meter setting is governed to some extent by geographical location and local conditions, the remarks that are to follow must of necessity be confined more or less to a particular section and will apply to Virginia—more particularly the western part where the writer has been located for the last several years.

The ownership and location of the water meter are

two subjects on which divergence of opinion exists. In the writer's opinion the meter should be owned by the water department or company (being charged to capital account) and all maintenance should be done by the owners and charged to operating costs. In Virginia the meter setting just inside the curb line offers so many advantages over other locations that these readily outweigh any disadvantage in the nature of a small additional installation cost should this be the case. In a good many houses in this section of the country there are no basements in which to locate a meter.

Although there may be a large number of snows during the winter, especially in the more mountainous sections of the State, they are not very deep and do not as a general rule remain on the ground for any length of time. Snows, therefore, do not adversely affect any operation that might be necessary in connection with the curb setting of meters if properly installed.

The advantages of such outside setting, located in the sidewalk space are in general as follows:

(1) Meter reading is greatly facilitated due to the fact that the reader never needs to wait for a response from the householder on knocking, and should the party be absent it would necessitate making another trip to get the meter reading if the meter were located inside the house. The distance the meter readers have to walk is lessened when outside settings are used and this in turn permits more meters to be read per day.

(2) The meter is always accessible to water department employees for reading, inspecting, testing and repairing.

(3) The danger of the meter readers and other water department employees from attacks from vicious dogs is eliminated.

(4) The chance of unauthorized persons entering the house in the guise of water-works employees is greatly eliminated.

(5) Chance of the meter being covered up by rubbish, coal, kindling wood, etc., is done away with when the outside setting is used.

(6) More accurate readings can be procured when outside settings are used because of better lighting outside than generally exists in basements, under porches or other places where meters might be set.

(7) The line of separation between the water department and property owners' liability is clearly defined and there is not much chance of unauthorized connections being made behind the meter.

(8) In case of necessity of cutting off the water for nonpayment of bills there can be no dispute as to entering the premises if the meter and control are located at the curb line.

(9) The outside setting should be in a locked box and as it is below the ground is not so apt to be tampered with as would a setting in a more conspicuous place not protected by a box.

(10) Less danger of damage to the meter by hot water exists if set at the curb.

(11) Danger from freezing is practically eliminated in a well set meter and in case of fire in the building supplied, the meter is not in danger of being destroyed.

In view of all these reasons the writer is of the opinion that the entire meter setting, including the necessary cut-off valve, should be located in the sidewalk space behind the curb line, and that the water department's or company's maintenance and obligations should stop at the customer's side of the meter.

Type of Setting

The following remarks apply to the smaller size meter up to 1 in. and when larger sizes than this are used the conditions must be studied separately and settings made to suit.

It is realized that a properly set meter, although not always the cheapest, will receive more attention in general from the water works operatives and in turn pay higher returns to the department.

It is a good plan to set the meter in a yoke with at least a control valve at the inlet side, although some prefer valves at both the inlet and outlet sides. This does away with the customary curb stop and box.

The meter in its yoke, and with the control valve, should be set in an earthenware, concrete or iron box with sufficient clearance between the risers, if they be used, that the cold ground outside cannot cause the water in the pipes or meter to freeze. A type of box that has proven very satisfactory in our section of the country is one 18 in. in diameter and 24 in. deep with side slots at the lower end to accomodate the varying depths of the service pipe. The latter, we feel should be about 24 in. below the ground.

It is important that a lid be provided that fits the top of the box tightly, preferably being locked on, with some kind of a locking device. If the lid is fastened on there will be no circulation of air in the box and consequently no danger from freezing. Another advantage is that if the lid is kept on tightly there is less danger of persons tampering with the meters or of pedestrians catching their feet in the hole with a possible damage suit resulting.

It is also very important that the bottom of the box extend below the maximum frost line so that the warm air from below can rise up around the meter and risers and keep the atmosphere in the box well above freezing. In extreme cases it has been found that a smaller tile pipe about 8 in. in diameter put vertically into the ground below the bottom of the regular box to reach warmer levels overcame freezing troubles by admitting warmth from below.

Meter Reading

In the writer's opinion meters should be read monthly if this is possible as by so doing a closer touch is kept on losses and wastes and due to the visiting of each meter every thirty days the stopped meters and other irregularities can be more effectively dealt with. In case a customer has a leak he can be notified within a reasonable time if the meters are read monthly, but if they are read say quarterly the amount of leakage passed will more likely be an appreciable amount and cause some disagreeableness when an attempt is made to collect the bill.

Recent Experiences at Bluefield, Virginia

If you will pardon personal experiences it may be of some interest to tell how the Town of Bluefield recently attacked the problem of setting 700 meters at the rate of something like 100 per week. This was carried on as follows:

A work sketch was first made up and the various kinds of equipment decided on. After the meters, yokes, boxes and covers were ordered out, some figures were made up giving the length of pipe to be cut from the service to allow for elbows, yoke, valve, etc., and the vertical distance that the cover, meter, yoke and fittings required was figured and each made into a constant.

Actual installation started with several men digging holes, located from the curb boxes wherever possible, in a certain well defined section so that one foreman could keep all things going. Two men, both of whom had had some previous pipe fitting experience, were formed into a "gang" and given instructions how to set the meters and they then worked together for about a day. These men then were given a helper each and two setting "gangs" were formed and these two helpers were in turn given helpers and four setting "gangs" were formed in a few days and carried the work through, with as many men as it was necessary to prepare the holes ahead of them.

TOOLS REQUIRED

Each of these setting gangs of two men each was furnished with a ratchet die holder and one-half and three-quarter in. dies, a hack saw, two 10 in. Stillson wrenches, a pipe-vice attached to a four legged board, a homemade wooden straight edge and a pair of hip boots. The men provided their own rules. The meters, yokes, boxes, covers, pipe, etc., were supplied to the location by a Ford truck. Galvanized nipples of various lengths were purchased and used wherever possible as they could be purchased cheaper than we could buy, cut and thread the pipe.

When the hole was opened down to the service pipe the meter setting gang (two men) came along and the first thing they did was to lay the straight edge across the hole and measure down to the service pipe and from this the proper "constant," referred to above, was subtracted which gave the length of risers necessary to bring the top of the meter to the desired point below the meter box lid. If there was a standard nipple of length somewhere near this dimension it was used. If not, the helper would cut pipe to the proper length and thread it. The meter setter in the meanwhile would be cutting a piece of pipe of predetermined length out of the service line and threading the cut ends for elbows. The risers were then screwed in and the yoke and meter set, after which the box was put in the hole. By using a set of specially made hooks the box was easily adjusted around the meter and risers and the cover put on.

Two men constituted the back filling gang and followed up all setting gangs, backfilling all holes and seeing that the lids were properly fastened.

If the existing cut-off in the service line was so that it could be used to control the water it was used but if not the meter setter would cut and thread the pipe under pressure, which only took a very few minutes. He would screw the riser pipe with control valve on, bail out the hole and go on without having to dig back to the main or cut the water off of a section of the town. The water lost amounted to very little.

One foreman looked after the entire job and 700 meters were set at the rate of about 100 per week.

The cost of this work complete, including tools, boots, and everything was slightly under $19.00 per setting which also included the changing of some services where it was necessary.

We believe that in a place where the services are fairly close together one foreman could handle about six meter setting gangs with the necessary hole diggers and could set about 150 meters per week, providing that everything is thoroughly planned ahead.

[*Editor's Note.*—The above paper by Mr. Reuhl was read before the Virginia Water and Sewage Works Association at Lynchburg, Va., November, 1931. In view of the interest shown and lengthy discussion which followed we have printed the paper in full. It represents the kind of paper that is of interest to Water Works Superintendents or Managers—too few of which appear on Water Works Association programs.]

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Fall Meeting, New England Sewage Works Association

The 1931 Fall meeting of the New England Sewage Works Association was held at Providence, R. I., on Oct. 19th. Headquarters for the meeting were at the sewer maintenance building of the Providence Sewer Department. Ninety-four members and guests were registered for the meeting.

The meeting convened at 10:30 A. M., with President W. J. Scott presiding. An address of welcome to the Association was delivered by Mayor Dunne of Providence. Frank E. Waterman, Commissioner of Public Works, also spoke to the members, extending the hospitality of the Department of Public Works to the Association.

The first paper of the morning session, entitled, "Sewer Maintenance," was presented by John H. Brooks, Jr., of Worcester, Massachusetts. In the absence of Mr. Brooks, his paper was read by Willis E. Cary of Worcester. This paper was discussed by W. E. Saunders of Providence and several other members.

The second paper, presented by E. S. Chase of Boston, was entitled, "Sand Filtration." This paper was discussed by H. E. Holmes, H. P. Eddy of Boston and several others.

As the last paper of the morning session, J. W. Bugbee described the methods of sewage disposal used in Providence, outlining previous methods and changes now being made.

Following the discussion of the papers, a brief business session was held.

Following the morning session a buffet luncheon was served in an adjoining room in the Sewer Maintenance Building.

At 2:00 P. M. the members were taken on a tour of inspection of the sewer maintenance building, the yard, pumping station and the disposal works which were undergoing reconstruction, including changes in methods of treatment and an opportunity was afforded the members to study the details of design of several units.

In addition to the disposal plant, the association was invited to inspect the plant of the Field's Point Manufacturing Co., adjacent to the disposal plant to observe the manufacture of liquid chlorine.

Following the inspection trips, the meeting adjourned to the Edgewood Yacht Club for dinner and the evening meeting.

During the evening Round Table Discussion on the following topics was held:

1. Operating Difficulties with Imhoff Tanks, introduced by Mr. Van Kleeck of Hartford, Conn.
2. Odor and Fly Nuisance, introduced by R. S. Lanphear, Worcester, Mass.

Messrs. Chase and Ellsworth described their interetsing observations of sewage treatment in Europe during visits which they have made to various European countries recently. Mr. Chase illustrated his talk with moving pictures which he had taken of many of the treatment plants in Europe and United States.

During the year membership has increased to 115.

The Annual Meeting for 1932 will be held in Boston.

F. W. GILCREAS, Secretary.

PROGRESS IN SEWERAGE PRACTICE: A REVIEW OF CURRENT LITERATURE

LITERATURE, dealing with sewerage problems, published during the last few months, covered a wide range of subjects.

New Construction.—Some of the items of outstanding interest are the proposal to construct an activated sludge plant and trunk sewers[1] for 22 municipalities in Middlesex County, England, at an estimated cost of $21,900,000; the enlarging of the sewage works at Stuttgart, Germany,[10] with Imhoff tanks, secondary sludge digestion tanks and trickling filters; and the construction on Ward's Island[13] of the first unit in New York City's $300,000,000 program for sewage treatment and disposal. This plant will employ the activitated sludge process of treatment, and will be the largest of its kind in the world. It is to be built at a cost of approximately $30,000,000, and will be the first of 33 plants which will embrace all five boroughs of New York City. Practically all sewage pollution will be eliminated from the Harlem River and a substantial amount removed from the upper East River. A new activated sludge plant is also being completed at Stahnsdorf[14] for the treatment of the sewage from Berlin, Germany. The first section of this plant will handle from 26 to 40 M. G. D. The total flow from Berlin is between 150 and 170 M. G. D.

Plant Operation.—Numerous articles pertaining to small plant construction and operation were published. Among these were included the plants at Woonsocket, R. I., and Elyria, O. The plant at Woonsocket[18] is of the activated sludge type, built at a cost of about $365,000 to treat the sewage from 60,000 people. On Oct. 2, 1931, an explosion of gas in the sludge digestion tanks[15] killed two workmen and blew the roof off the tanks. The exact cause of the gas ignition has not been determined. The plant at Elyria, O.,[12] also of the activated sludge type, is designed to serve a population of 36,000 at an average rate of 3.6 M. G. D. The plant consists of bar gratings, grit chambers, primary settling tanks, aeration tanks, sludge settling tanks, heated separate digestion tanks and glass-covered sludge beds. The total cost of the plant proper, exclusive of land, was $394,000.

Considerable difficulty was experienced with iron pickling wastes at this plant, as was also the case at Fostoria, O.[20]

Data of interest regarding the operation of the mechanically cleaned fine screens (Dorr) and the incineration of the screenings have been obtained at Long Beach, Calif.[8] These screens, which gradually became clogged with grease and required cutting out of service and cleaning with a wire brush once a week, were each provided with a 2-in. water pressure pipe and nozzles, working under a pressure of 60 lb. By cleaning the screen daily at night with this water jet it is necessary to wire-brush the screens only once every 60 days.

The screenings from this plant, which treats 10 M. G. D., amount to 2,100 lb. per million gallons with a moisture content of 90 to 92 per cent. The screenings are burned in two incinerators, equipped with Pumix gas burners, at an approximate cost of $1.06 per M. G. of sewerage or $1 per ton of wet screenings. It takes 1½ cu. ft. of 1,200 B.t.u. gas to burn 1 cu. ft. of wet screenings with the gas costing 15 ct. per 1,000 cu ft. The ash from the screening after burning weighs 50 lb. per cu. ft., and is used for fertilizing purposes.

At Dayton, O.,[9] the screenings are first dewatered to about 60 per cent moisture in a hydraulic press before being incinerated. The total operation cost including fuel, labor, and repairs for the year 1930 was 71 ct. per M. G. of sewage treated. The cost of gas, rated at 1,100 B.t.u. was 55 ct. per 1,000 cu. ft. Labor charges covered cost of pressing and screening as well as incineration operation at a rate of pay of 50 ct per hour.

Grease Removal and Disposal.—An experimental grease and oil removal tank has been constructed at the sewage works of Pasadena, Calif.,[4] similar to those used by Imhoff in Germany. The tank is 10 by 32 ft. in plan and 3 ft. deep, with 30 porous plates, each 1 by 2 by 12 in. in the bottom. Air under pressure is blown up through the plates, and the grease and oil are emulsified. This material is retained behind a floating wooden baffle, and removed by hand. The detention period in this tank is 1.3 min. As some of the excess oil escapes, however, to the activated sludge tanks, it is planned to increase this detention to 3 min. Twenty cubic feet of scum is removed daily, and buried in trenches. Prior to the installation of this tank it was frequently necessary to employ from 4 to 10 laborers for several days to remove the grease from the surface of the aeration tanks, at a yearly cost of $1,200 to $1,500.

This removal of grease and oil from the Hyperion sewage works, Los Angeles, Calif.,[5] has become imperative both as a protection to the Dorrco fine screens and also to the beaches in the vicinity of the outfall. Numerous experiments, using various systems of grease removal, including the Imhoff type of grease tank, were tried. A new type of tank of a novel design was found to give the best results. The bottom of the tank slopes towards the middle, and makes an angle of about 40° with the horizontal. The sewage in the inlet channel to the tank is aerated by discharging screened sewage under a high pressure through nozzles into the raw sewage. These nozzles are placed about 2 in. above the surface of the sewage. In passing through this 2-in. space each fast-moving stream of water carries a large volume of air into the sewage body. At the inlet end of the grease removal tank the velocity of the sewage is less than 0.5 ft. per sec. at maximum flow. The effluent passes out of the tank through a slot at the tank bottom. The emulsified grease collects on the surface of the sewage, and is removed at one side of the tank by means of a Link-Belt scraper. From 50 to 75 per cent of the grease in the sewage was removed by this tank.

Imhoff Tanks.—One of the recent Imhoff tank installations is that at Stuttgart, Germany.[19] These tanks have been constructed as an addition to the old plant, and are designed to treat the sewage from 108,000 persons, or a sewage flow of 61 M.G.D. The tanks are 91 ft. by 65 ft. in plan and 52 ft. deep. These units are probably the deepest that have ever been constructed. They have a detention period of a little over 2 hr. with a sludge digestion capacity of 4¾ cu. ft. per capita.

In dewatering the sludge with a pH value of 6.7 from the Imhoff tanks, at Lebanon, Pa.,[8] alum is used, causing quick coagulation and release of the water. The alum is added in the ratio of 1 lb. per cu. yd. of sludge at the rate of 0.8 gal. per min. This treatment was found to reduce the time required for drying the sludge by about 33 per cent.

Sprinkling Filters.—Studies have been conducted for 8 months on the comparison of different media in an experimental filter[10] at Plainfield, N. J. The media under observation are crushed stone, slag, gravel, and galvanized wire mesh. The filter units have an effective depth of 5 ft. each, and receive 4,750 gal. daily of settling tank effluent. Samples were collected at different levels in the filters.

The "building-up" processes, regardless of filter media was gradual, and took place over a considerable period. There was no definite demarcation between the building-up and the regular operation of the filter. During the process of "building-up" the zone of nitrification moved downward. Aside from the fact that considerable ammonia is lost into the air, nitrade productions at the different levels of the beds was greatest when ammonia reduction was lowest. The reduction of ammonia was in no way parallel with the increase in nitrates.

The ease and rapidity of self-cleaning were greatest in the crushed stone, followed by the gravel, and were least in the slag. The gravel was found to have a tendency to discharge smaller quantities of film over a longer period than the crushed stone. Remarkable oxidization was brought about by the aeration of the sewage in passing over the wire mesh and in connection with the removal of colloids. The greatest suspended solids removed occurred in the filters with the roughest material, whereas the greatest unloading occurred in the smoothest.

The results to date indicate that while from a bacteriological standpoint all stone media may be equally efficient in B coli removal, there seems no doubt that from a chemical standpoint the slag performed best, followed by crushed stone and gravel.

The effectiveness of the filter as a straining device was greatest in the upper layers; this is true for suspended solids removal, B. O. D. and B coli reduction.

Slag for Trickling Filters.—Hommon finds that slag is a durable media for sewage filters.[2] This conclusion was based on field investigations of nearly 50 sewage-works, including some using other filter media. Specifications as to the size and gradation suggested by Mr. Hommon are as follows:

The material shall be graded within the following limits as indicated by round hole laboratory screens:

1¼ to 2½-in. size:

Passing 2½-in. screen	95-100	per cent
Passing 1¼-in. screen	0- 5	per cent
Passing ¾-in. screen	0- 2	per cent

2½ to 3½-in. size:

Passing 3½-in. screen	95-100	per cent
Passing 2½-in. screen	0- 5	per cent
Passing 1 -in. screen	2	per cent

The 2½ to 3½-in. size is recommended but either of the above sizes may be used.

Sludge Treatment.—Results of experiments on different mixtures of fresh and digested sewage sludge, in which either the fresh solids, digested sludge, or both, were treated with Fe Cl_3 show that gasification was markedly retarded when treated digested sludge or treated fresh solids plus treated digested sludge were used.[7] The treatment of fresh solids alone hastened the rate of digestion, but resulted in an intermediate quantity of gas. Volatile matter reduction was but slightly less during the first two weeks, in the treated mixtures than in the control. The indications are that liquidification was not greatly hampered by addition of the chemical.

The ripe sludge obtained from the treated mixtures were again used for seed material to determine the after effects of the treatment. Preliminary results showed a marked increase in gas production from the digested sludge previously treated with Fe Cl_3.

A process whereby fresh sewage solids are deodorized with the production of a high-value fertilizer base is being developed at the Atlantic City Sewerage Co. The process consists of encouraging the growth of molds[9] in the partly dried material by proper temperature and environmental conditions. Considerable heat may be generated during the process, but there is no disagreeable odor. The sludge is being sold in Atlantic City for $20 a ton.

Novel sludge digestion tanks have recently been completed at the Joint Disposal Plant of the Los Angeles County Sanitation Districts[11]. In designing these tanks, advantage was taken of the fact that sewage sludge, when digested generally has a higher specific gravity than when undigested. In a series of 4 tanks in each of 2 batteries, the inert solids, which settle to the bottom of each tank, progressively move forward by gravity to the top of the next tank. Thus the lighter, more volatile materials are left behind for a longer digestion period. Interior circulation of the sludge is handled by gas lifts operating on the air-lift principle. In addition to vertical circulation, these lifts disturb the bottom sludge enough to keep it in motion.

Each battery is about 150 by 50 ft. in plan with a sludge depth of 15 ft. The capacity of each battery is about 900,000 gal., which will treat the primary clarifier solids from 20 M. G. D. for an 18-day detention period. The two batteries were built at a cost of $110,000, or a cost of $2,750 per M. G. of flow.

Miscellaneous.—Experiments on slag sludge beds at Lebanon, Pa.,[8] have resulted in the replacement of the sand bed by one of slag, excellent results being obtained at a considerable saving in cost.

The sand (Jersey gravel) cost $2.50 per ton, whereas the slag cost only $0.60 per ton. The sludge beds are now re-surfaced with slag about every four months, at an average cost of $30—as compared with $125 when sand is used.

A novel method of auxiliary psychoda fly control[12] has been used at the sewage works of Schenectady, N. Y., to replace the usual spraying program, consisting of singeing the Psychoda with a portable, oil-burning torch.

With furnace oil costing 8 ct. per gal. in small quantities, the cost of fuel is 2.8 ct. per 1,000 sq. ft. of surface covered. The time requried to singe 1,000 sq. ft. is about 7 minutes. The usual costs of spraying would be 5 to 7 times as much.

A novel means of tracing the source of oil in the sewage system of San Antonio, Tex.,[13] consists of suspending wooden floats, which have been painted white, in the sewers. Where oil is present, black marks are left on the wooden blocks. By continuing to observe these blocks the source of the oil can frequently be found.

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Mud Removal from Sedimentation Basins, St. Louis, Mo.

A total of 435,302 cu. yd. of mud was removed from the sedimentation basins at the Chain of Rocks plant of the Water Works of St. Louis, Mo., during the year ending April 13, 1931. The following notes on the methods employed are taken from the recently issued annual report of J. L. Rilliet, Jr., Water Commissioner of St. Louis.

The material deposited in the basins at the Chain of Rocks plant is usually removed by three separate and distinct methods as follows:

(1) By periodically flushing the mud out through the sewer gate while the basin is in service.

(2) By draining the basin completely through the sewer gate, thus removing all of the floating mud and a portion of the solid mud.

(3) By means of tractors, labor and flushing, thus removing all of the remaining mud.

On account of the location of the single sewer outlet in each of the basins, the first method is least satisfactory because not a great deal of mud can be removed economically unless very close attention is given to the density of the effluent from the sewer outlet. When using this method, samples are collected at regular intervals, and the percentage of solids is determined. It is a rule that when this percentage falls below 10, the sewer gate is closed to allow the floating mud to equalize. The operation is then repeated.

During the past year the sewer gate from No. 1 basin was partially open at various intervals for a total period of 1,342 hours. The per cent solids of the effluent from the sewer outlet varied from 4 to 28, the average being 14 per cent. During this period about 7.81 million gallons of water were wasted. This water carried with it about 6,760 cu. yd. of solids. At $10.55 per million gallons, the cost of basin water during the previous fiscal year, the cost of the water wasted amounted to $82.40 or a cost of $0.0122 per cu. yd. of solids removed. Properly designed multiple outlets or ejectors placed at a number of low points in the bottom of the basin might remove the floating mud more satisfactorily.

The second method of cleaning the basins appears to be the most economical. In the past this method has been considered as incidental to the third method in that all basins cleaned must be drained before the men can enter it for final cleaning. During the coming year the second method of cleaning will be given a trial, i. e., basin No. 1 will be drained and then immediately filled up again without putting men and tractors in it for cleaning. Of course there are limitations to this method. Sand cannot be moved, so sometime during the year, perhaps in the fall the basin will have to be drained and thoroughly cleaned by men and tractors. Another factor to be determined is whether or not any taste or odor will be imparted to the water by stirring, in filling or by permitting the heavy sludge to remain in the basin during an entire year. Another factor which will enter into the economy of the method will be the degree to which the mud remaining will compact during the year, this affecting the cost of the final thorough cleaning.

The third method, while the most satisfactory, is also the most costly. The greatest item of cost is that of the water wasted in flushing. The tractors will loosen the mud but it requires a lot of water to move it to the sewer. Then again, leakage through stop planks and gates during the 16 hours of each 24 that no work is done adds considerably to the water wasted.

Basin No. 1 was cleaned twice and basins Nos. 2, 7, 7½, 8 and 9 were each cleaned once. The cost of removing 239,933 cu. yd. of mud by draining was $0.0062 per cu. yd. while the cost of removing 188,609 cu. yd. of the more solid mud by labor, tractors and flushing was $0.0221 per cu. yd. As previously mentioned the cost of removing 6,760 cu. yd. of the floating mud by method (1) amounted to $0.0122 per cu. yd. The grand total amount of mud removed from all sedimentation basins by the three methods during the year was 435,302 cu. yd. The total amount of water used in moving this material amounted to 356.88 million gallons, costing $3,767.53. The cost for labor and material was $1,971.86, making the total cost of removal $5,739.39. This is equivalent to a cost of $0.0132 per cu. yd. of material removed.

VIRGINIA WATER AND SEWAGE WORKS ASSOCIATION

IN the December issue of WATER WORKS AND SEWERAGE there was given an account of the meeting of the Virginia Water and Sewage Works Association which was held at Lynchburg, Va., Nov. 16 and 17, 1931. This account, however, did not include excerpts from the technical paper read.* These are presented now.

Papers and Discussion

"Lynchburg's Water Supply."—C. L. DeMott, C. E.

Having served for several years in the capacity of city engineer of Lynchburg, Va., the author, who is now a member of the city council, was well qualified to recount the history and developments in Lynchburg's water supply.

Mr. DeMott said that the town of Lynchburg with 3000 population in 1828 had employed an engineer who devised a scheme for getting its first public water supply. For the purpose $50,000 in bonds were sold and James River water was pumped by a water-wheel driven pump at the rate of 4000 gal. per hr. against a 240 ft. head to a reservoir.

In 1904 the James River was abandoned because of increasing pollution and $700,000 was spent to develop a gravity supply from a mountain stream—the Pedlar River. Since 1919 the latter supply had been filtered. In 1919 the consumption reached 6.5 m.g.d., but that metering had been started in 1920 and the city was now 100 per cent metered. This had resulted in a reduced consumption in 1930 to 60 per cent of that shown in 1920 and therefore he believed that metering had proven the best investment the city had ever made.

During 1931 the dam on Pedlar River was raised to increase the storage to 600,000,000 gal. Two thirds of the watershed is Government owned and is being reforested and protected against fires without cost to the City.

H. M. Sears, U. S. Forester, spoke of the value of the litter deposits under trees on watersheds which served as a great sponge to hold the precipitation and allow it to later enter the ground water feeders to reservoirs. It was, in his opinion, the most valuable part of the forest in preserving water supply. The cities of Staunton, Harrisburg and Woodstock, Va., were others securing their water supply from National Forest watersheds and the state forester was also making efforts to protect water-supply-sheds not now in National Forests. He recommended a forestry committee for every Chamber of Commerce as a great step toward conserving woodlands and water supply.

R. F. Wagner, Director of Water Supply at Lynchburg, stated that the work going on in the Natural Bridge Forest Area had proven all important; that reforestation had "saved the day" in 1930-31 when otherwise the serious drought would have depleted the Lynchburg supply to the serious extent that others had suffered. One indication of the value of reforestation had been found in the lessened turbidity of the Lynchburg supply which had not exceeded 100 p.p.m. since reforestation whereas it had reached 800 p.p.m. on many occasions before.

In reply to a question **Richard Messer,** Chief Engineer, State Department of Health, stated that the State Forest Service sells trees for municipal reforestation.

"Control of Tastes and Odors in Impounded Waters"—Jas. M. Caird, Chemist, Roanoke Water Works Co.

The author reviewed the several sources of tastes and odors in water supplies and measures available to prevent or remove these. Among other things he had found that decomposition of algae and organic matter in the pipe system—particularly out on dead ends—had in many instances been the source of foul tastes.

In reservoirs the decomposition of organic matter in the lower strata would cause the reservoir to "turn over" without temperature change of consequence having occurred. He was convinced that the gases liberated in the decomposition process had

**Editor's Note.*—The Virginia Water and Sewage Works Association through its Secretary, H. W. Snidow has supplied WATER WORKS AND SEWERAGE with a complete set of papers read, with the request that they be printed in full. We take pleasure in so doing in this and the issue following.

Some of the 85 Registrants at the Virginia Water and Sewage Works Association Meeting, Lynchburg, Va., Nov. 16-17, 1931

rendered the specific gravity of the bottom water higher and thus had caused it to come to the surface by way of a "turnover." From such disturbances bad tastes and odors usually resulted because of the products of decomposition which were thereby distributed through the water.

Mr. Caird compared copper sulphate and chlorine treatment for algae control but thought the former could best be used on impounded or stored raw waters. Chlorine alone, or better yet, in combination with ammonia, would serve for treated-water and service reservoirs. He was strongly convinced of the merits of raw-water chlorination and its value in keeping filters in good condition and reducing operating costs. He referred also to the recent successful use of activated carbon in taste control. Nowadays, said Mr. Caird, one selects the treatment which best suits the condition, whether it be the use of permanganate, ammonia or activated carbon, or a combination of any of these.

F. J. Sette, Professor of Sanitary Engineering, Virginia Polytechnic Institute, outlined methods employed to overcome algae and taste troubles at Pulaski, Va. The Pulaski supply is impounded in a deep reservoir on a mountain watershed. After the reservoir turnover the hydrogen sulphide (H_2S) content in the water had risen to 8 p.p.m. and the carbon dioxide (CO_2) mounted to 30 p.p.m.

In 1930 the leakage under the dam had been heavily chlorinated and pumped over the dam to the surface of the reservoir and an interesting thing had happened. The growth of Dinobryon in the reservoir had suddenly dropped following this return of chlorine containing water. The treatment was stopped and the counts increased threefold shortly thereafter. During the treatment some residual chlorine could be detected a considerable distance back from the dam.

"Open Service Reservoirs and Their Contamination"—H. A. Johnson, Superintendent of Filtration, Danville, Va.

The City of Danville, Va., has two open service reservoirs on the opposite ends of the distribution system and 6 miles apart. The North Side reservoir being on the end away from the filter plant has but little replacement of water. Bacterial aftergrowths in this reservoir had been pronounced as a result of this. Application of calcium hypochlorite powder (H.T.H.) in quantities of 10 to 12 lb. per treatment, applied by dragging behind a boat burlap bags containing 1 lb. of the powder at each filling, had helped reduce the bacterial counts in the reservoirs materially. An increased chlorine application at the filter plant had controlled the aftergrowths in the Ballou Park Reservoir (that near the filter plant) during the Summer of 1930.

During July 1931, the ammonia-chlorine treatment had been started at the filter plant and in consequence residual chlorine was present in the water all over the system and in the North Side Reservoir as well. The most satisfactory results had been secured with a ratio of 1 ammonia to 3 chlorine. A higher ratio of ammonia had slowed down the sterilization too much. The improvement in the bacterial quality of samples from the distribution system had been marked during the past summer.

R. L. Warren, Superintendent of Water Works, South Boston, Va., recounted his experiences with an open service reservoir on the opposite end of the distribution system from the filter plant. He had calculated that only about 10 per cent of the capacity of the reservoir was replaced daily with new water because it merely "floated" on the system. They had also found it of some help to apply hypochlorite (H.T.H.) to the reservoir and had had algae growths which this treatment had helped control. Some difficulty had been had with taste production in the system and they planned to use the ammonia treatment to correct the reservoir troubles and at the same time to prevent tastes. Arrangements to secure better displacement through the reservoir were also planned.

"Removal of Tastes and Odors at Norfolk, Va."—R. W. Fitzgerald, Chief Chemist, Norfolk Water Department.

At Norfolk very bad conditions had to be coped with following the reservoir turnover and at such times prechlorination of the raw water had not been all that might be desired insofar as taste troubles were concerned. Not until they had applied powdered activated carbon to the raw water had thorough taste removal been realized. This practice at the larger (Lake Prince) plant had given results after four days. At the Moore's Bridge plant the carbon had been applied to the filter influent with almost immediate results. Discontinuing the application had resulted in complaints from consumers. Since the introduction of the process, during early July of 1931, their requirements had averaged 0.09 grains per gallon of "Nuchar" at a cost of 70 ct. per million gallons treated and they at Norfolk felt the slight added cost well worth while.

"Removal of Tastes and Odors at Newport News, Va."—E. F. Dugger, General Manager, Newport News Water Commission.

The author stated that very excellent taste removal had been secured at Newport News filtration plant through use of powdered activated carbon applied just ahead of the filters. He had been impressed with this treatment because it was the first to his knowledge wherein nothing was passed on to the consumers in the shape of chemicals added. His had been the first plant in the state to adopt the activated carbon process and the results and low costs (75 ct. per million gallons) had been most gratifying. Roughly a dosage of 2.5 to 3 p.p.m. was being maintained.

Within 8 hours after starting the treatment in June, 1931, a severe taste has been corrected in the city about 8 miles from the filter plant and the treatment has been continuous since. His experience of passing through a Summer and Fall without complaints of tastes had been a novel one and he felt justified in continuing the treatment.

[*Note.*—Mr. Dugger's paper appeared in full in the December issue of WATER WORKS AND SEWERAGE.]

It was pointed out by **R. F. Wagner** that Lynchburg had previously corrected taste and odor troubles by aeration but more recently the "Aeromix" system had been installed to secure thorough mixing of chemicals and aeration at one operation and without additional pumping being required.

Richard Messer explained some of the advantages of powdered activated carbon and recounted his experiences in introducing the treatment in Virginia —having first tried it experimentally at the Portsmouth, Va., filter plant early last Summer.

Mr. Fitzgerald in reply to a question said that he had favored carbon application to the raw water in

preference to applied water at Norfolk. It (the carbon) seemed to keep down putrefaction of sludge in the basins and that now 9 weeks between cleanings had replaced the practice of bi-weekly cleanings, which on his large basins meant a money saving in water conserved and labor saved.

"Mixing and Coagulation at Richmond, Va."—was the subject of an illustrated talk made by Marsden C. Smith, Engineer in Charge of Water Supply and Electricity at Richmond, Va.

Because of industrial pollution of the James River, the mixing arrangements and effective coagulation of the water had proven to be one of their most important problems. Among other things they had found prechlorination of the raw water very helpful and had equipped themselves to use one ton chlorine containers during the past Summer. Cross baffles added to the "around the end" style mixing chamber had been helpful in securing more violent mixing in the 10 minute chamber.

To improve coagulation mechanical devices had been specially designed and located within the coagulation basins at the entrance end. This equipment consisted of horizontal shafted paddle-wheels rotating similarly to the paddle wheels on stern-wheeler river boats. The first set produced more violent rotation and subsequent sets (3) operated at gradually reduced speed of rotation. In this coagulating or "floc" gathering section of the basins a 60 minute contact was available and just beyond it the "floc" would settle very quickly in contrast to the indifferent coagulation secured prior to the introduction of these "flocculators." The results to date had been nothing short of startling. The alum requirement had been cut by 1 full grain in a water hitherto considered as relatively easily coagulated, and with more difficult waters (low stream flow and high organic matter concentration) they should expect the most marked effects. They had observed an increased length of filter runs and better color reduction and alumina removal with consequent improvement in visible appearance and palatability of the finished water.

[*Editor's Note.*—Mr. Smith is preparing for a paper with ilustrations of the "flocculation" equipment for publication in a later issue of WATER WORKS AND SEWERAGE. The new equipment has at this writing been in service for about 6 weeks only and detailed results would be premature.]

"Metering"—E. H. Ruehl, City Manager, Bluefield, Va.

The author of this very practical paper covered the "Do's and Dont's" which he suggested following when undertaking to meter a small city or town.

To increase the temperature in meter boxes located at the curb (found in practice to be the best location), a novel scheme had been developed. He had sunk a section of 4 in. terra cotta pipe vertically below the bottom of the meter box and this serves to convey warmer air from below up into the meter box and thus reduces the likelihood of meter freezing.

He had found that complete installations of ⅝ in. straight meters with everything included could be made for the average cost of $19.00 per meter installed.

Mr. Ruehl's paper is printed in full elsewhere in this issue.

In reply to questions **Mr. Ruehl** stated that vitrified meter boxes have certain advantages and cost but $1.15 each delivered at Bluefield. All meters are installed with the yoke connection which he considered decidedly worth the cost because of ease of removals for inspection, repairs, etc. The tops of the meter boxes were metal and had the worm type of lock which has definite advantages. He had always preferred a 11 in. diameter opening in the meter box cover for ease of removing the meter and the top of the meter was uniformly 10 in. below the top of the box. He had not used copper tubing for services but expected to do so in future installations.

In discussion **R. F. Wagner** made the very interesting remark that if Lynchburg had not been metered when it was, they would have had to spend $2,000,000 to increase their water supply facilities.

A. Wagner related an experience of a small town in Virginia where metering had reduced water pumped from 150,000 gal. per day a few years ago to 70,000 gal. now being consumed by an increased population.

H. E. Beckwith in reply to a question from the Chair concerning "unaccounted for water" stated that meters may show on the average about 70 per cent of the water entering the distribution system. His experience had shown that a loss of 3000 gal. per day per mile of mains plus a meter slip of 5 per cent represented a fairly good record for unaccounted for water. In exceptional cases 85 to 90 per cent of the water entering the system could be accounted for but there were many with as low as 30 per cent accounted for.

Mr. Ruehl remarked that while metering was the first step in water conservation and economy, he realized the importance of Pitometer surveys as a means of locating unaccounted for water.

Copper Service Pipe and Fittings.—One of the questions in the "Question Box" had to do with copper services and fittings used. Apparently the earliest use of flexible copper tubing for services was that at Baltimore in 1924. In present day practice diameters up to 2 in. are used, but at Staunton, Va., they had found the 2 in. size rather hard to work with and install none larger than 1¼ in. which is now used exclusively for crossing the street to the curb boxes in which one pipe from the main is "yoked" out to two meters. Lynchburg uses ¾ in. to 2 in. sizes and considers that the use of flexible copper tubing has saved the Water Department considerable money.

It appeared that but little experience had been had with the "streamline" type of fittings for copper tubing and the "flared" type had been used almost exclusively with satisfaction.

One member described a unique method of replacing old services with copper tubing in which a pipe-pusher was used in reverse for pulling out the old pipe and the copper tubing followed behind. (For a complete description of this method see WATER WORKS AND SEWERAGE, Nov. 1931, "Labor Saving Method of Making Service Renewals," p. 341.)

Reforestation Practice and Cost.—In answer to a question from the "Question Box," **H. M. Sears,** U. S. Forester, said that the species of trees used in reforestation were selected to meet the local conditions—usually the best native growing species would prove the best. Artificial planting was not resorted to unless the self-seeding method was a failure. In planting, about 1000 trees to the acre were used, which would give about a 6 ft. by 7 ft. spacing. Trees that had been 1 to 2 years in the seed bed and

2 years additional in the transplant bed to produce bunchy roots gave the best results and that these could be secured at $3 to $5 per 1000 from the State Nurseries (delivered). The total cost for trees in the ground would run to between $9 and $14 per 1000 and that would likewise be the per acre cost. The coniferous trees usually proved the most satisfactory—short leaf pine and yellow pine with yellow poplar being those used in the Natural Bridge Forest.

"Some Notes on Electrically Driven Centrifugal Pumps."—H. E. Beckwith, The Pitometer Co., New York City.

Mr. Beckwith presented convincing data to illustrate a method for computing pump efficiencies and power costs which if actually applied would frequently reveal startling facts. Sufficient money might be saved in a short period of operation to pay the cost of replacing a less suitable pump with a new pump so specified as to have the most efficient characteristics for the job at hand. It was usually not appreciated that an increase of 60 per cent efficiency to 70 per cent efficiency would often justify the purchase of a new pump to secure that 10 per cent increase. In other instances it might only prove neccessary to have the impeller changed slightly. Use of oversize pumps which necessitated throttling of the discharge line valve was extremely poor economy and it would prove better economy to purchase a smaller capacity pump.

Mr. Beckwith advocated the practice at some plants of showing on the station report (for the period covered) the computed volume of water pumped per K.W.H. of power consumption. From such data it would be simple to check up on the pump efficiency at any time by use of the method illustrated. Should low efficiency be detected it had been his experience that the power companies and pump manufacturers stood willing to assist in bringing the plant to its expected efficiency.

If it be assumed that the motor is 90 per cent efficiency then the overall efficiencies (power input to water pumped) should be as indicated for various pump capacities:

G.P.M. Delivery	Per Cent Efficiency
200	49
400	54
600	58
800	60
1000	63
1500	67

Sewage Treatment

"Experiences in Starting a New Sewage Treatment Plant."—S. L. Williamson, City Engineer, Charlottesville, Va.

Mr. Williamson described the two new sewage treatment plants of Imhoff tank type which had been built under his supervision and placed in operation in the early part of 1931 at Charlottesville, Va. An interesting design feature was the use of slabs of soapstone for the sloping walls in the flow chambers; this in order that the solids might slide down through the slots more easily. Another unique feature was the use of concrete slabs (4x4 in.) placed close together within the gas vents for the purpose of keeping the scum submerged at all times to prevent crusting over and caking—the gases escaping through the cracks between the slabs.

In starting the plant only one section was placed in operation. Digested sludge from another plant was introduced for seeding and thereafter sludge liming daily was maintained but in spite of all this the sludge went through an acid period and not until 10 weeks later did real gas production get under way. In the meantime prechlorination of the crude sewage had been started and the rate of 12 parts per million chlorine dosage had maintained residual chlorine in the tank effluent. When the second unit was placed in service the period before real gas production got under way was but 4 to 5 weeks. Mr. Williamson stated that all of the evidence points to the fact that prechlorination had brought about a reduction of acid production in the sludge digestion compartment and had sped up digestion. The second unit was not limed as heavily as had been the first (without prechlorination) and yet its performance was more satisfactory in every way. Experience with the automatic type of chlorinator had indicated its value in sewage chlorination because chlorine is not wasted when the flow decreases.

[*Editor's Note.*—Mr. Williamson's paper appears in full on another page of this issue.]

"Operating Results at the Blacksburg, Va., Sewage Treatment Plant."—F. J. Sette, Professor of Sanitary Engineering, Blacksburg, Va.

The sewage treatment plant serving the town of Blacksburg and the Virginia Polytechnic Institute consists of an Imhoff tank, contact beds and sludge drying bed. The contact bed effluent passes through secondary settling tanks and discharges to a very small stream.

Professor Sette's studies of the Blacksburg plant had indicated that the Imhoff tank was up to par in performance, but the contact beds filled and discharged so slowly (4 hours being required to empty) as to reduce their efficiency greatly at times. The reduction of the 5-day BOD value of the applied (settled) sewage had averaged 68% (74 p.p.m.) leaving 37 p.p.m. in the effluent. Suspended solids in the effluent had averaged 42 p.p.m., representing a 52% removal. The total reduction for the plant had been fairly satisfactory—the average being 86% of the 5-day BOD, 70% of the oxygen consumed value and 85% of the suspended solids. At present the plant is operating at only 60% of its assumed capacity.

The gas domes on the Imhoff tank vents had had to be removed because of scum collection under them. Prof. Sette found the sludge very well digested and carrying 94% moisture and 50% volatile matter. The designed sludge bed capacity of 0.48 sq. ft. per capita, under glass covers, was seemingly too small even at the present 60% loading on the plant.

"The Hollins Sewage Treatment Plant"—W. M. Johnson, Wiley and Wilson, Engineers, Lynchburg, Va.

The author described a small sewage plant which had been designed by his firm and built as a rush job in 65 days, in order to take crude sewage out of a creek which was then open sewer as a result of the pronounced drought of 1930-1931. The plant consisted of bar screens, an Imhoff tank and sprinkling filter of the English type with an Adams rotating distributor which operates under a 12 inch head. The effluent is given final sedimentation. Prechlorination is provided for odor prevention and final chlorination for disinfection and further oxygen demand reduction. The sludge beds are enclosed under glass

covers and the Imhoff tank vents are closed and the gas is burned. Although the plant is located 900 feet from the nearest building its operation has been free of odor nuisance. The combination of prechlorination and the gentle application of sewage from the revolving filter distributor would seem to be jointly responsible for the very satisfactory results.

Round Table Discussion

Under the leadership of Lee Williamson, Consulting Engineer, Richmond, Va., there developed a very interesting "round table" on sewage treatment in which operating troubles were thoroughly discussed. In the end it developed that operation was of more importance than design and it was conceded that the designing engineer would do well to require that operation of new works be under his supervision and guidance for the first year of the plant's existence, if not longer.

H. W. Snidow gave small plant operators some very desirable operating suggestions and stressed the need for good operation practice if the plants were to function as intended.

Richard Messer, Chief Engineer of the Virginia State Department of Health, in a very enlightening review indicated what had been accomplished in the stream pollution work in Virginia and called attention to the progress which industrial plants had made in removing wastes from Virginia streams—notably the West Virginia Pulp and Paper Co. at Covington, Va., and the Mathieson Alkali Works, Inc., at Saltville, Va., where in both instances a heavy expenditure had been required.

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West Shore Water Producers* Meet

The meeting was held at the Skokie Country Club in Glencoe, Ill., where an excellent dinner was served at 7 p. m., Dec. 9, 1931.

Mr. E. L. Pflanz, superintendent of the Glencoe filtration and pumping plant, opened the meeting and introduced Mr. Young, Manager of the Glencoe water department who welcomed the operators.

Mr. J. J. McCarthy, of Racine, Chairman of the Association, called attention to the meeting Jan. 13, 1932, and suggested an election of new officers at that time, a more formal organization of the association, the appointment of some committees, and the inauguration of some co-operative studies on plant conditions and operations, with the results of these studies made available in printed or mimeographed form to the members.

Mr. J. R. Baylis, of Chicago, suggested that one co-operative study might be of the passing of flocculated matter through filters, especially in cold weather. All plants represented agreed that they would like to take part in such a study and Mr. Baylis agreed to forward to each plant some material outlining the methods for such a study. Mr. Baylis further suggested a study of filter sand.

Mr. L. I. Birdsall, of The General Chemical Co., suggested the possibility that passing of floc through filters might be due to the breaking loose of matter already entrapped in the bed, and that prechlorination might prevent this. This was offered as a possible line of investigation, and not as his opinion of what actually occurs.

Mr. E. L. Pflanz read a paper describing the superchlorination used at Glencoe. Excessive chlorine is added at the point where the water enters the mixing tanks. It is dechlorinated at the point where it leaves the plant to go into the city mains. Eight to 12 lb. of chlorine per million gal. of water with a 6-hour retention period through the plant seems to give them satisfactory results. This gives a residual chlorine by orthotolidin of about .5 p.p.m. before dechlorinating. In periods when the algae tastes were strong a residual before dechlorination as high as 2 p.p.m. was carried. Sodium hyposulphite, sodium sulphite, and anhydrous sodium bisulphite were tried as dechlorinating agents, and the best success has been obtained with the latter, containing 65 per cent available SO_2, fed with a dry feed machine. This treatment has been very successful in preventing and removing objectionable tastes from the water.

Mr. Birdsall described taste conditions at Minneapolis where the addition of small parts of chlorine accentuated the taste, but the addition of as high as 30 or 40 lb. per million gal. removed it, apparently by oxidation. Dechlorination was necessary in this case of course.

Mr. Frye reported that at Evanston he had higher bacterial counts on agar plates with his filter effluent after prechlorination was used than before. The treatment was used only a few days, and the consensus of opinion seemed to be that it was not used long enough to effect sterilization of the beds.

There was discussion on expanding the organization to include plants inland and along the southern end of Lake Michigan.

The next meeting will be held at Lake Forest or Kenosha, notice to be sent out by the chairman. The meeting will be Jan. 13.

A motion was made by Mr. Prindle and seconded by Mr. Ashworth to thank Mr. Pflantz for his very fine paper and for the hospitality of Glencoe.

JEROME C. ZUFELT, Secretary, Sheboygan, Wisc.

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Water Consumed in Gas Operated Refrigerators

Among other matters, the water consumed by gas-operated refrigerators was discussed at some length at the December meeting of the New England Water Works Association.

It developed that complaints had been registered with several water departments because of the increased water bills of householders since the water cooled type of gas-operated refrigerators had been installed. Some of the discussors stated that the ordinary water meters did not register the slow but continuous flow passing through these refrigerators.

D. A. Heffernan, superintendent water works at Milton, Mass., started the discussion by stating that they at Milton figured each household size refrigerator, on the average, would use 10 cu. ft. of water per day, equivalent to 27,000 gal. per year, which at the rate of 25 ct. per 100 cu. ft. would run the water bill to $9.00 per year, but the consumption would vary with varying conditions. Others reported a consumption of 60 gal. per day on the average, equivalent to about 22,000 gal. per year.

*An Association for the advancement of information concerning water supply practices and the treatment of Lake Michigan water in particular.

EDITORIALS

Chemical Engineers and Stream Pollution

AT the recent meeting of the American Institute of Chemical Engineers (A.I.C.E.) a symposium on stream pollution occupied a full day of its program—seven papers being presented on the subject. Its chairman explained that the amount of time being devoted to stream pollution topics had seemed propitious in view of the fact that "the public and the press were rapidly becoming pollution conscious" and it was expedient, therefore, to give more attention to the matter.

The membership of the A.I.C.E. is to a very large extent composed of leading chemical engineers in American industry—men who know most about the nature and quantity of wastes that are being discharged into our stream by industrial plants. When such men look seriously into the matter of curtailing stream pollution much can be accomplished in the direction of stream cleansing.

Members of the American Society of Civil Engineers (A.S.C.E.) have wisely and properly proposed to the A.I.C.E. that a joint committee composed of members of these two national engineering societies be set up for the purpose of assembling data and correlating the work that is being carried on in stream pollution investigations and waste treatment studies in America. That such an organized effort will do much to prevent duplication of endeavors directed toward stream pollution abatement seems evident. The work of studying trade waste treatment could be properly allocated, the exchange of information would prove valuable and the whole program should prove a scientifically and economically sound one. To this suggestion from members of the A.S.C.E., supported by its secretary, who said that they as civil engineers felt that the cooperation of the chemical engineer would prove of considerable value in several matters of interest to the civil engineer—not the least being stream pollution problems—the A.I.C.E. has lent a willing ear. What develops remains to be worked out.

Interesting the chemical man in stream pollution would seem a most effective step in the right direction—particularly the men who are in responsible charge of industrial operations and know the processes involved in producing noxious wastes. These men are best prepared to recommend measures for reducing and treating wastes and, what is more important, reducing plant losses through the sewers in many cases.

In the papers read in the symposium, the keynote struck was that curtailment of stream pollution might best be begun by making changes and improvements within the plants producing the wastes and that only the non-recoverable residue should have to be dealt with ultimately in a waste treatment process. It was further indicated that the "measuring sticks" in the nature of laboratory tests applied in determining the required degree of waste treatment to be employed in municipal sewage problems were frequently useless and even sometimes misleading when applied to industrial waste problems. It is apparent that the biological methods must give way to more purely chemical and physical processes when it comes to treatment of trade wastes and furthermore that a non-existing type of "expert" must be forthcoming to deal with such problems. The chemical engineer is naturally the best qualified to fill that place. Sanitary engineers will find his cooperation of great value in that important and unsolved problem of "stream use without abuse."

Steel and Water

ON the "Big Board" and the ticker-tape the symbol for the bell-weather of stocks known to the clientele of brokerage offices as "Steel" is X. On the board it usually appears above the quotation column in red and designates the stock of the U. S. Steel Corporation. Of the several water company stocks listed on the Stock Exchanges there is none known as "Water" and neither is the symbol (H_2O) used to guide the novice who might perchance recognize the chemical formula among the other hieroglyphics used to designate various stocks. But of course "Water" would never do—that along with "buckets" is tabu in shops which carry an expensive sign on the door that reads, Members New York Stock Exchange.

The answer is probably simple. Water has no attraction for magnets or magnates—steel does. Water is a commonplace thing, while steel is spectacular—that is to say it has been. The point of this story is that right now the tortoise has the laugh on the hare—the tortoise being in this instance the lowly water companies. A glance at the statements of the net earnings of the water companies vs. those of the steel companies in America during the years 1930 and 1931 is convincing. The comparison of dollars earned per share of stock outstanding is even more so. Water companies are not operating at 30 per cent of capacity. Their plants are not shut down and little is heard of wage cutting by them. Price cutting, competition and the size of "unfilled orders" are not some of their worries. They do not maintain trade associations or institutes to regulate production and consumption of the commodity produced or to create new markets and outlets for the product of that industry to predict how far "around the corner" business improvement is. Perhaps they could gain, however, by so doing and an organized group of producers and purveyors of water might accomplish much in the nature of general advancement as well as specific good for the water supply industry.

While a city the size of Philadelphia in its business of water supply finds its balance sheet in such poor shape that it arouses the ire of its citizenry by a proposal to increase water rates by 5 per cent and causes its mayor to weep aloud over the "bad financing", the water companies in America are paying dividends and earning them. So much for Steel and Water!

A New Use for Sewers

IN Europe one hears of human as well as other rats that make their homes in the large sewers of Paris and elsewhere. Sewers are used, frequently with disaster, as a playground for urchins seeking the thrill of "explorers." Sewers have been used for disposal of all manner of cast off clothing and household goods—even a mattress or two at times. In America a more recent use, which has caused much difficulty at sewage treatment works of the activated sludge type, has been

the dumping of spent mash from the manufacture of *spiritus-fermenti* and home-brew operations.

In Italy the sewers were suspected of housing operations of the anti-Fascisti during a visit of the great Mussolini.

In America a new and hitherto unreported use for sewers came to light a few weeks ago when burglars in Los Angeles used a trunk sewer as their starting point of tunneling operations, 60 ft. to a point directly beneath the vaults of a branch of the Security-First National Bank. Two charges of dynamite blew the vault to pieces and the burglars escaped with about $15,000 in cash.

The sanitary engineer of tomorrow may be required to incorporate "burglar-proofing" processes in specifications covering sewers construction or remodelling.

Water Sheds and Christmas Trees

EVERY "Santa Claus" that has recently purchased Christmas-Tree in the market-place at prices varying from six "bits" to a two dollar bill will find food for thought in the plans now in the making for harvesting spruce trees from reforested water sheds for the Christmas market. The wholesale price averaging 30 ct. per tree it is predicted will more than support the reforestation program, beginning with the first harvest representing a 5-year growth from bed stock two years old. After the first ten years, between 2,500 and 3,000 Christmas trees per year in an estimated harvest.

The Department of Agriculture estimates that every fourth family has a tree at Christmas—the requirement for the country being between 5,000,000 and 10,000,000 trees. New York City and the New England States alone use about 1,500,000 trees. This year a greater proportion of hemlock than ever before appeared in the markets—the more desirable spruce bringing a premium.

It would seem that there should be a future in watershed reforestation for the dual purpose of entering the Christmas tree business as well as conservation and protection of water supply.

Metropolitan Water Consumption

IN the metropolitan area of London the average water consumption is a little over 36 gal. per capita and that in the metropolitan area of New York is about 134 gal. per capita—a difference of approximately 100 gal.

Excluding that supplied by private companies, the daily consumption in the five boroughs of greater New York was 945,000,000 gal.—almost three times the quantity furnished in London to 7,700,000 people. New York collected about $27,000,000 and London about $25,000,000 a year for water, indicating a rate in New York of but slightly more than one-third that charged in London, but London has a deficit of $400,000 from its water service this year. An appeal has been addressed by the Metropolitan Water Board of London to water consumers, calling attention to the heavy expense caused the board as a direct result of wasteful and extravagant use of water during the past year.

When water is measured by meter New York charges $130 per million gal. or when sold on a property frontage rate to unmetered consumers the yield is only about $65 per million gal. London's revenue represents about $247 per million gal.

The New York Sun states that "at the rates charged in London, New York would have an annual profit of $50,000,000 which would enable the city to build the proposed Delaware River works out of current revenues without incurring any bonded debt." The Sun might have added that consumption reduction by metering or some other method would have delayed the Delaware River project—indefinitely perhaps.

If London continues to be healthful and sanitary with a water consumption of less than 40 gal. per capita per day is there much excuse for the wasteful American practice that has been responsible for expensive litigations or that increases materially the expense involved when providing sewers, sewage pumps and treatment works to handle the extravagantly "spent" water supply and also adds materially to the property owners' burdens rather than that of the consumers.

In these days of economic stress it may be eminently proper to extend water works and sewage systems at this time in order to give relief to the unemployed, but at the same time there may be some reason to argue that reduced municipal costs brought about by elimination of the extravagant and wasteful use of water might be passed on to the unemployed and the business of water supply be placed on a sounder footing thereby.

The Late C. H. Koyl

CHARLES HERSCHEL KOYL, engineer of water service of the Chicago, Milwaukee & St. Paul Railroad, died Dec. 18th at the age of 76, in Evanston, Ill.

Forty-five years ago, while a student at Johns Hopkins University, Mr. Koyl became interested in municipal water treatment and later became a pioneer and leader in the field of industrial water supply treatment. His attempts to interest municipalities in softening hard waters were only partially successful—the public of yesteryear was not concerned. In another direction, however, he pioneered with success.

On one of our great transcontinental railway systems—the Great Northern Railroad—Koyl found progressive ideas were being used wherever applicable, and he interested them in water service control. The engineering department asked Koyl if he "could do anything to better a water that was costing the company about $4,000 a year per engine for repairs"—made necessary because of the use of hard alkaline waters. He made it plain that he could and served the Great Northern system for seven years, since which he has served another great railroad system—the Milwaukee—for the past eleven years up to the time of his death.

Koyl developed many ingenious schemes for treating waters for use in locomotive boilers and proved to the satisfaction of all that his work repaid the operators many times over as evidenced in the complimentary remarks concerning his accomplishments made recently to this writer by Ralph Budd then President of the Great Northern Railway System.

This is briefly the history of a pioneer and one of the foremost water engineers in the railroad field. It was as a result of Koyl's accomplishments that other railway systems followed the lead of the Great Northern in providing water service control.

L. H. Enslow

IOWA CONFERENCE ON SEWAGE TREATMENT AND WASTES DISPOSAL

By E. L. FILBY

THE 13th Iowa Sewage Treatment Conference and the 5th Annual meeting of the Iowa Wastes Disposal Association, held at Ames, Ia., Nov. 18, 19 and 20, were attended by about 60 members and guests.

Iowa, with its hundreds of small municipalities and public water supplies, has a problem of waste disposal that necessitates continuous study. With several hundred sewage treatment plants functioning satisfactorily there are still many problems of design and operation that remain to be solved.

Lindon J. Murphy of the Engineering Extension Service, Iowa State College, opened the program with a paper on **"Sewage Treatment and the Public,"** stressing the fact that a sewage disposal plant is a public utility and as such needs intelligent operation and the funds for this must be secured from public appropriations. The public must be "sold" on the plant. It must be pleasing to the senses, attractive, and a place a citizen can "point to with public pride." It should be easily accessible by good roads and attractively landscaped, etc. Advertising the plant can best be done by word of mouth, visits of citizens and officials and courteous, intelligent explanatory talks by the operator. The new sewer rental law passed last winter by the Iowa Legislature paves the way for some sorely needed funds for plant operation at a number of places. No city has, however, to date adopted the local legislation necessary to put the law into effect.

W. Scott Johnson, Chief Public Health Engineer of the Missouri State Board of Health, followed with a closely related paper dealing with **"The Sewage Works Operator's Job."** Not only must the operator know his plant and the functions of the component parts but he must always be alert to educate the public as to the plant and its needs and accomplishments. Cost of operation data must be accumulated, observations as to stream and sewage flow, weather, and performance must be recorded and above all the plant must be "sold" to the public through the medium of the press, talks before luncheon clubs, etc. Too frequently it happened that the investment of the city in a plant which has been well designed and built, is then unfortunately turned over to a laborer to operate. Good operation will result only when the city realizes that it has obligations to protect public health and to prevent nuisance.

Mayor H. H. Canfield, of Boone, related how his city had built a treatment plant after settling several damage suits. An Imhoff tank-sprinkling filter plant had been built at a cost of about $100,000 and operating expenses alone now run about $1,400 per annum. The plant is adequately fenced and the surrounding area beautified. The city of Boone is quite proud of the plant and classifies it as one of the municipal utilities. Operation is under general direction of George Nelson, City Engineer.

The first afternoon was devoted to a discussion of **"Why Should Municipalities and Industries Treat Their Sewage Wastes and How They Can Do It."** Mr. Nelson of the Door Company read **Mr. Frank Bachman's** paper which stated that the public has become sewage treatment conscious and local enforcement agencies such as Health Departments, Conservation Commissions and recreational interests have been strengthened by legislation. The reasonable use of streams has superceded the older opinions concerning riparian rights. Economic conditions now are such that municipal credit should be extended to construct such works. Labor is plentiful and needing work, materials are low in priec, design has progressed so that plants can be built architecturally acceptable and free from odor and operating nuisance. Methods of sewage treatment were listed and some cost data as to operation of separate sludge digestion plants given. Cities were cautioned to most carefully select their consulting engineer and after that to follow his decisions.

Mr. Howard Green, President of H. R. Green Co., Engineers, Cedar Rapids, outlined **"How Sewage Treatment Can Be Financed."** Iowa statutes permit the levying of general levy taxes, special assessments and sewer rentals. A plant can be built on the same basis as the sewer itself. Assessments cannot exceed 25 per cent of fair property value and are payable in 10 equal installments with 6 per cent interest. Special assessment bonds (10 year 5 per cent serials) can be issued in anticipation of these revenues. If a bond issue is proposed, it, with other bonds, cannot exceed 5 per cent of assessable property values. Bonds must be sold at par and may be issued by city councils without vote of the people. Bonds can be issued in anticipation of sewer rentals and these bonds are in the same category as special assessment bonds. The state secretary of the budget may approve a transfer of money from water and light funds to disposal plant fund to allow construction. A general discussion of the validity and marketability of such bonds ensued. Problems of finance seem to deter much needed work at this time.

The Iowa State Board of Health program of abatement of stream pollution by the larger cities, and cleaning up of pollution along the Des Moines, Cedar and Iowa Rivers was briefly discussed.

Professor W. E. Galligan closed the program with a discussion of elementary hydraulics that a sewage plant operator should know.

On the 19th **Professor Jack J. Hinman,** Chief of Water Laboratories, Division of State Hygienic Laboratories, Iowa City, discussed the **"Effect of Stream Pollution on Public Water Supplies."** He pointed out that cold weather and ice cover on streams extended the zone of pollution by preventing sedimentation and absorption of oxygen. Sewage

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In 1927 Wauwatosa installed a 500,000 gallon "Pittsburgh-Des Moines" elevated tank and in 1928 a 1,000,000 gallon "Pittsburgh-Des Moines" elevated tank. This new elevated storage provides a uniform water pressure to take care of their maximum consumption, and permits a simplified pumping schedule during the off-peak hours on the water lines. It also prevents tearing up city streets to install new water mains.

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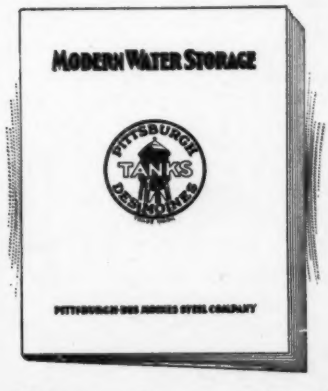

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pollution increases water treatment plant problems. Tastes and odors result; coagulation is difficult; etc. Stream pollution has been responsible for poisonous substances in the water supplies which caused enteric disturbances such as at Charleston, W. Va., and Louisville, Ky., during low stream flows last year on the Ohio River. Blue-green algae may have been the cause. The use of activated carbon and ammonia-chlorine in controlling tastes and odors was discussed. Public demand is now for clear sparkling water free from objectionable tastes and odors at any cost. Sewage treatment must take a part of the load off of water purification plants, if water purification plants are to satisfy public demands.

Professor Max Levine gave a most interesting and instructive discourse on **"How to Use Bacteria in Sewage Disposal."** The use of these very minute living plants to burn up (oxidize) the sewage solids was explained. The engineer must know some habits of bacteria and provide for the proper environment so that they will function as they should. The effect of temperature was stressed. Perhaps in the future sludge digestion may depend upon the functioning of high temperature loving bacteria which thrive between 130 and 140 degrees Fahrenheit.

Professor Earl L. Waterman of the University of Iowa described various types of sewage settling tanks and explained reasons as to why they are constructed as they are. Septic, Imhoff, plain settling and separate sludge digestion tanks were discussed.

Round Table on Foaming Troubles

A round table discussion of causes and prevention of foaming of sewage tanks followed. Attention was directed to the acidity of the liquid between the top of sludge and the gas vents, the period of sludge ripening for orderly digestion, adequate sludge capacity, etc. The use of lime introduced into the gas vents below the floating scum was the general accepted method of control. Acidity was classified as a symptom of foaming, and not necessarily the cause. The presence of such materials as "home brew mash" in the sewage was also thought to produce foaming. Mention was made of the withdrawal of unripe sludge at the Mason City plant during the winter. Allowing it to freeze resulted in a sludge that dried readily and caused no nuisance. Garage wastes were discussed and the concensus of opinion was that in future plant designs these would have to be taken into consideration and oil removal at the sewage plant proper must be arranged for.

Mr. Scott Johnson delivered a paper on **"Keeping Sewage Works Records"** stressing the fact that such records are the only evidence of the success or failure of the plant and that records are a most essential part of plant operation. Records are the only defense in case of legal liability. Records are useful in determining the cost of operation, they indicate improvement in operation, and indicate the necessity of future repairs and additions and how they should be made. Records take the "guess" out of plant design. They can be used as the basis for annual reports, talks before councils, etc. Regular records are far superior to spasmodic records and can be used to prove that the operation of a disposal plant is a worth while job. They take the "guess" out of plant results.

C. H. Currie, Consulting Engineer of Webster City, gave a short talk on **"Financing the Operation of Sewage Works"** stating that the city could levy a "millage" for such funds or collect sewer rental. He stressed the need of interesting the public in the plant and its problems. Once the public realizes the needs, funds will be forthcoming.

Jack Hinman, Jr., returned to discuss **"The Chemistry of Sewage Treatment."** He mentioned the various wastes comprising the sewage flow and their influence on plant operation. Especially troublesome are the high sulphates of the water supplies. He mentioned the various industrial wastes of complex chemical nature and the need for considering them in plant design and operation. The presence of poisons in the sewage may create trouble in the final diluting water. The use of chlorine as a method of delaying chemical changes and decomposition was illustrated.

A demonstration of tests used at sewage works to check operation was given by **Wm. R. Mark, Jr.,** Assistant Engineer, State Department of Health.

The evening of the 19th was devoted to the annual banquet. **Dean Anson Marston** gave a most interesting talk on the development of sanitary engineering in Iowa. He mentioned a concrete sewer installed in 1872 and still in use. He described the Cameron septic tank units and how Knoxville, Ia., had led the fight to have the patents held invalid. Iowa has also developed data on loadings permissible in sewer pipes and early investigated the role of bacteria in sewage treatment. Recent work by Dr. Max Levine on creamery waste disposal was cited as present day activity. Problems of the past were those of small cities—problems of today are those of the larger cities.

Round Table on Sewage Filters

The last day of the conference was devoted to **"Sewage Filters and Their Operation." Professor Earle Waterman** outlined the various types—the reasons for their use and problems of operation.

W. A. Stanley outlined some **"Factors Affecting the Efficiency of Filtration"** and dealt with the character of filtering material, method of distribution of liquid, ventilation of bed, character of growths within the bed, etc. He indicated that clogging of the beds ruined their action and suggested consideration of flooding, chlorination and entomological population as methods of eliminating pooling and clogging. **L. P. Ellerbroek** stressed the need of designers considering the size of filter stone most economical for quarry operators to produce. He urged consideration of 1¾ in. to 3 in. stone.

C. H. Currie and **Max Levine** discussed the question of **"Gas Recovery from Sewage Sludge and Its Economic Use."** Demonstration was given of gas production from sludge and its use as a fuel. Presday uses seem to be primarily for incineration of screenings and heating of sludge digestion tanks, rather than for power generation.

An inspection trip to the Ames and the State College sewage treatment plants occupied the last afternoon.

New Officers

Dr. Max Levine was elected President of the Association for 1931-32. Also elected were Earle L. Waterman, Vice-President; George Nelson and Lafayette Higgens, Directors; Linden J. Murphy re-elected Secretary-Treasurer.

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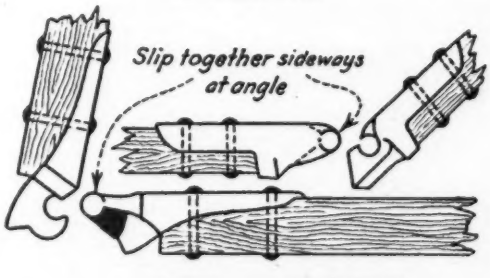

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NEW EQUIPMENT AND MATERIALS

Chain Belt Co. Announces the Tow-Bro Clarifier

As an addition to its present line of sewage disposal plant equipment the Chain Belt Co. of Milwaukee, Wis., announces the Tow-Bro clarifier. This is an advanced design of mechanism developed particularly for secondary settling tanks in activated sludge plants. It is also recommended for final settling ("humus") tanks in trickling filter type plants. For primary settling tanks, their chain and scraper type mechanism is recommended.

Rex "Tow-Bro" Sludge Collector Pipe

The Tow-Bro type mechanism consists essentially of a vertical revolving shaft having near its lower end, radial headers, diametrically opposed, and located parallel to the tank bottom. Each header has a series of sloping inlet nozzles, which just clear the bottom of the tank, so arranged that the nozzles in a single revolution of the headers, sweep clean the entire bottom of the tank. The inner ends of the headers converge into a central outlet connected to the sludge pipe line. The slowly revolving mechanism collects the sludge from the tank bottom and carries it through the headers to the center outlet, the removal being done by hydrostatic pressure. The headers and nozzles are made of an aluminum alloy.

Header and Nozzles Rex "Tow-Bro" Sludge Collector

The particular advantages claimed for this equipment are "that more concentrated sludge can be obtained together with more accurate control over the depth of the sludge blanket in the tank. On account of obtaining a more concentrated sludge, there is less material to be pumped as returned sludge, and more space is therefore available through the aeration and final settling tanks.

The sludge is removed from the entire tank bottom yet does not have to be scraped from the outside edge toward the center, so that the sludge has less chance to become septic because it is in the tank a comparatively short time. On account of the sludge being removed from the entire bottom of the tank, a better settling condition is obtained together with a clearer effluent. There is less agitation to the sludge in the tank bottom as the revolving headers are about 30 in. above the tank bottom and the mechanism is not moving the sludge in the tank but removing it through the nozzles and headers from the place where it settles on the tank bottom.

With a tank having radial flow, the lighter solids will settle around the outside edge of the tank where the lowest velocity is obtained. With the Tow-Bro clarifier, this lighter sludge does not have to be moved half way across the tank to the center sludge outlet but is removed from the point where it settles.

There are four clarifiers of this type now in operation at the Milwaukee Sewage Treatment plant and these have given very satisfactory performance. The first installation of these clarifiers was made over three and one-half years ago. The accompanying photographs show this mechanism installed in a slightly modified type of square concrete tank."

"Filclorator"

The Filclor Co. of Philadelphia, Pa., is offering the "Filclorator"—a piece of equipment intended to remove impurities from chlorine gas before the latter reaches the chlorine control equipment. As the accompanying illustration illustrates, it is connected to the outlet valve on chlorine cylinders or ton contains. Its primary purpose is that of stopping and collecting impurities which otherwise would clog the control equipment. The end sought is to eliminate equipment shutdowns for cleaning, insure more dependable operation and continuity of chlorination and reduce expense of maintenance and nuisance involved in removing stoppages for the chlorinators.

The "Filclorator"

The Filclor Company makes the following pertinent statements concerning the "Filclorator":

The prime purpose of the Filclorator is to remedy the most common and most annoying disturbances that result from the impurities found in commercial chlorine, and to effect a more positive and more economical operation of the chlorine plant by removing the impurities from the gas before it reaches the chlorinators.

In the "Filclorator" there is provided an embodiment of all operations necessary to cause all impurities, if present, to be deposited therein. The gas flows into a pre-expansion chamber through an orifice, the size of which is dependent upon the rated capacity of the particular flow with which the unit is to be used. As it enters this chamber there is a refrigerating or "chilling" action, due to the rapid expansion and the pressure reduction of the gas. Such impurities as hexachlorethane, etc., will be thrown down, deposited and thereby removed. The gas

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OMEGA also manufactures the well-known Omega Dry Chemical Feeders and Omega Lime Slakers in a wide range of capacities.

OMEGA has recently furnished chemical feeding equipment for water works plants at Detroit, Mich., Massillon, Ohio, Western Springs and Quincy, Ill., Ft. Worth, Tex., Thomasville, Ga., Newport News, Va., Kansas City, Kans., Oklahoma City, Okla., and many other cities.

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then permeates a suitable scrubber for further cleaning and thereafter passes into a second chamber provided for the purpose of removing all residual mechanical impurities present. This chamber is provided with a suitable scrubbing medium for additional cleaning, and an integral absorption filter through which the gas must pass, the relative porosity and permeability of which is such that no impurity as large as the smallest chlorinator orifice can pass through. The gas finally passes through an outlet orifice to the line connected with the chlorine control apparatus.

In short, while passing the "Filclorator" the gas is subjected to conditions now met in the chlorine control equipment. If there are impurities to be deposited the "Filclorator" catches them and not the chlorinator.

The "Filclorator" is of unitary design in order to provide a device which will conform to every requirement of simplicity. In this form it may easily be installed, will require no attention, and should be a most valuable adjunct to meet the particular need of plants located some distance from experienced help or where immediate factory service will not be available.

Much care and thought have been given to the selection of design and materials used in order to provide an economical accessory that will give indefinite service and stability of performance.

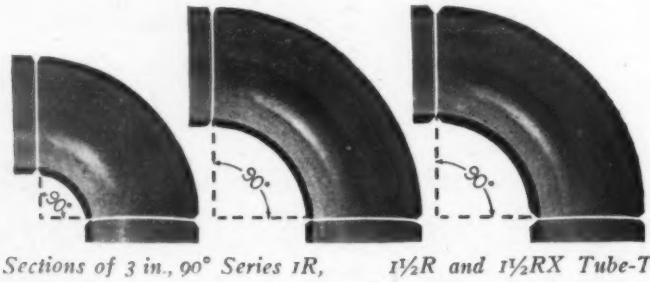
The "Filclorator" is so constructed that with slight variation it is applicable to any type or size of chlorine plant installation.

For further information apply to the Filclor Company, Commercial Trust Bldg., Philadelphia, Pa.

New Series of Tube-Turns

A new series of the seamless, uniform-wall fittings for pipe welding has been announced by the manufacturers, Tube-Turns, Incorporated, Louisville, Ky. Like all other Tube-Turns, the new Series 1R fittings are seamless. They are made by the exclusive Tube-Turn process, which is stated to produce uniform wall-thickness at all points, insure uniform radius and eliminate all locked-in stress in the metal. Like all other Tube-Turns, the new Series 1R also has the same outside diameter, the same inside diameter and the same wall thickness and wall tolerance as the pipe with which it is used. This, together with the fact that it is made of the same material, is said to greatly facilitate lining up and welding.

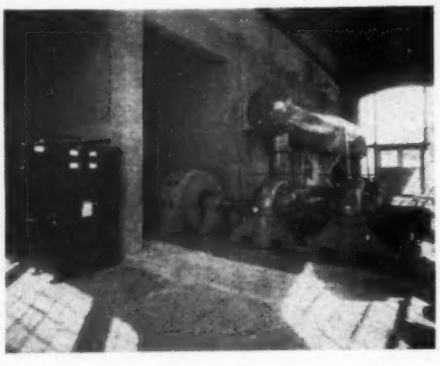
The addition of the new Series 1R rounds out and completes the Tube-Turn line, according to the announcement, affording 45° and 90° elbows and 180° return-type fittings for welding in sizes ¾ in. through 20 in. and in virtually all the weights required by modern piping.



Cut-away Sections of 3 in., 90° Series 1R, 1½R and 1½RX Tube-Turns

Pump Motor Uses Newly Developed Part-Winding Starting Method

The new part-winding starting method for alternating current motors, developed by Electric Machinery Mfg. Company, Minneapolis, Minn., was used in the pump installation shown in the illustration. In the part-winding method of starting motors, the stator is wound with two or more parallel circuits, one of the circuits is connected to the full line voltage at standstill, the other or others connected to the line at a later time during the starting period. This starting method is stated to have several advantages in simplifying control equipment and in providing smoother starting with less line disturbance when the motor is started.



Pump Installation of East Bay Municipal Utility District

The synchronous motor shown in the illustration is rated 1250 hp., 1200 r.p.m., and drives a high head centrifugal pump at the East Bay Municipal Utility District, Oakland, Calif. Motor is of the latest type fabricated steel construction. The part-winding starter which uses frequency-responsive relays for transferring to full winding and for synchronizing is shown at the left of the motor.

Cable Manhole Ventilator In New Handy Size

The Coppus Engineering Corporation of Worcester, Mass., has recently brought out a smaller cable manhole ventilator blower which they designate as size No. 150 S.M. It has a capacity of 950 c.f.m. free air, as against 1500 c.f.m. for the larger size.

Manhole Ventilator Blower

Size No. 150 S.M., like the larger unit, is built around the Coppus Vano Blower. The new unit is driven by a ¼ hp., 110 or 220 volt universal motor, operable on A.C. or D.C. current. Outfit comes complete with a combined switch and circuit breaker, 12 ft. of cord, and plug.

Unit is mounted by vertical swivel on a handy tripod. By means of a flexible canvas air tube, which can be obtained and attached to the diffuser, the volume of air may be directed right where needed.

Developed for ventilating cable manholes, vaults of electric light companies, and those of telephone companies, these blowers have been accepted for many other applications, such as the ventilation of sewers under construction.

New Western Connection for Lock Joint Pipe Co.

The Lock Joint Pipe Co. with general offices at Ampere, N. J. has concluded an arrangement with the American Concrete & Steel Pipe Co., of Los Angeles, Calif., whereby the American Company will manufacture and install lock joint steel cylinder reinforced concrete pipe west of the Rocky Mountains and in Texas. The American Concrete & Steel Pipe Company has done a large volume of work in the west in the manufacture of reinforced concrete pressure pipe and in the construction of pressure pipe lines for water supply, as well as in the manufacture of sewer and culvert pipe, and has established for itself a reputation for high standards and for excellent workmanship.

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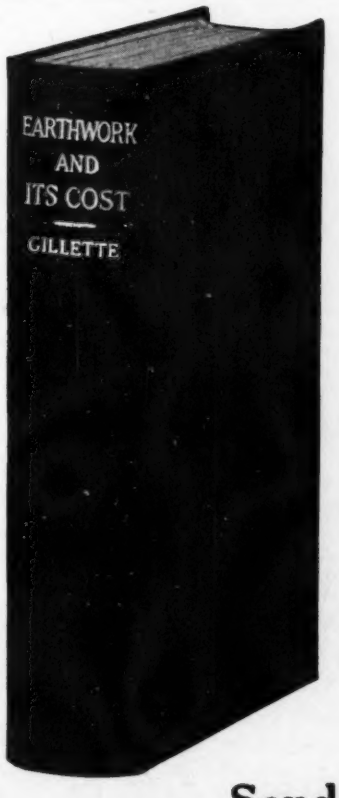

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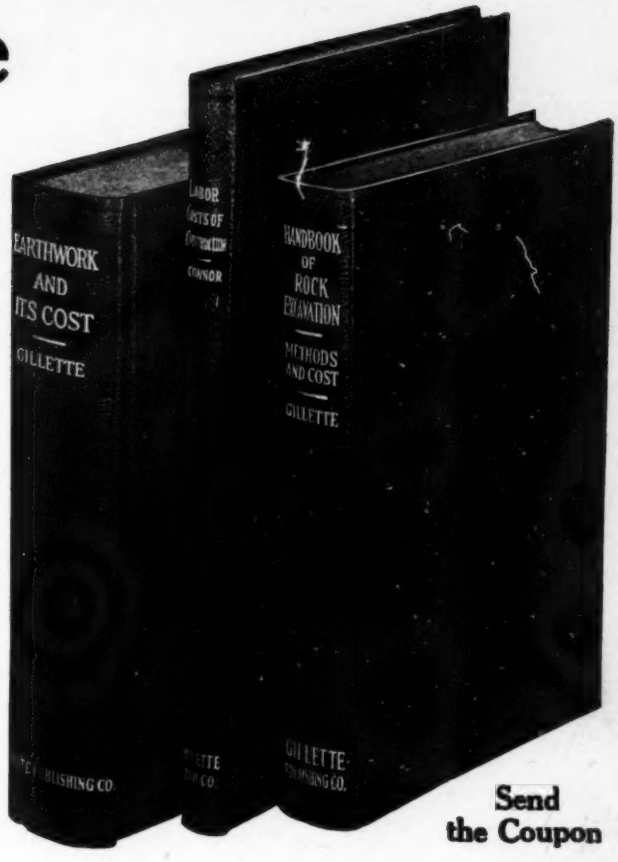

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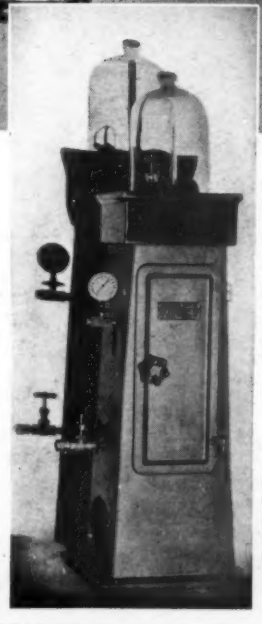

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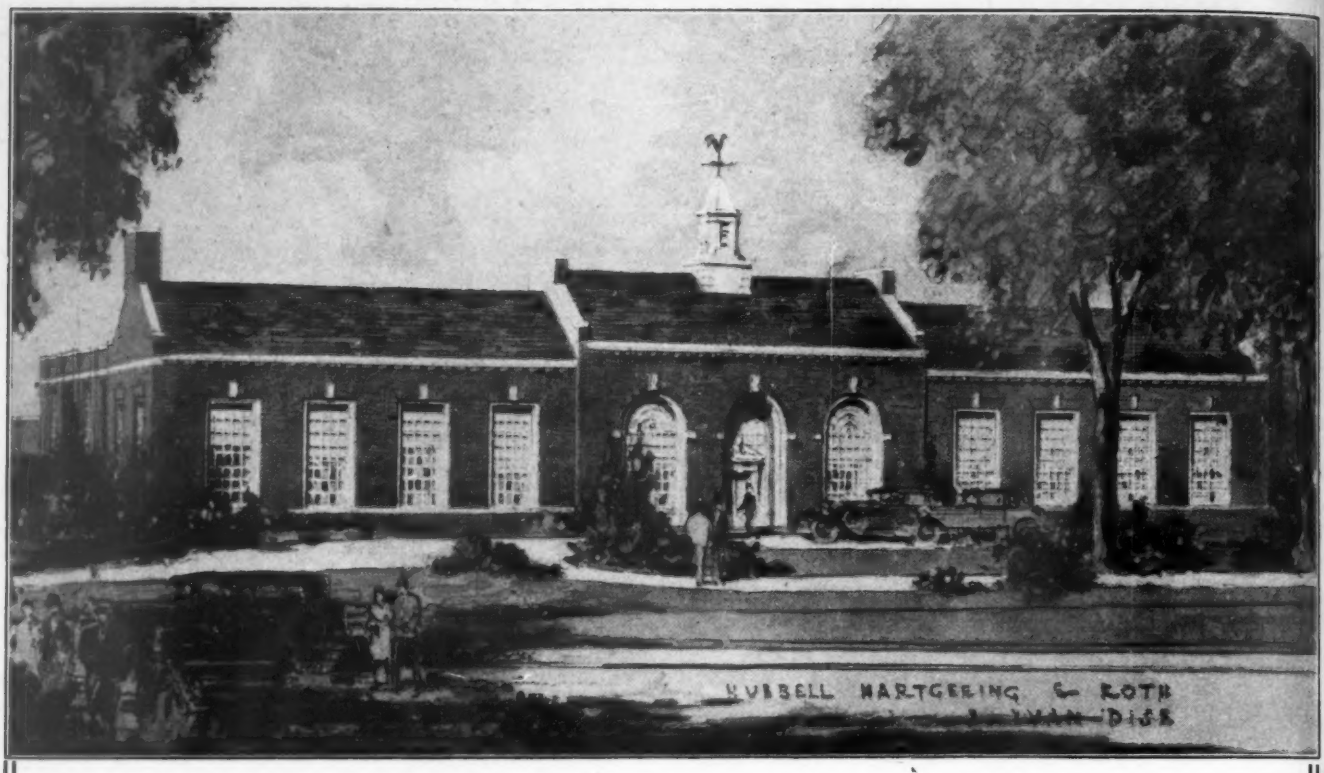

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